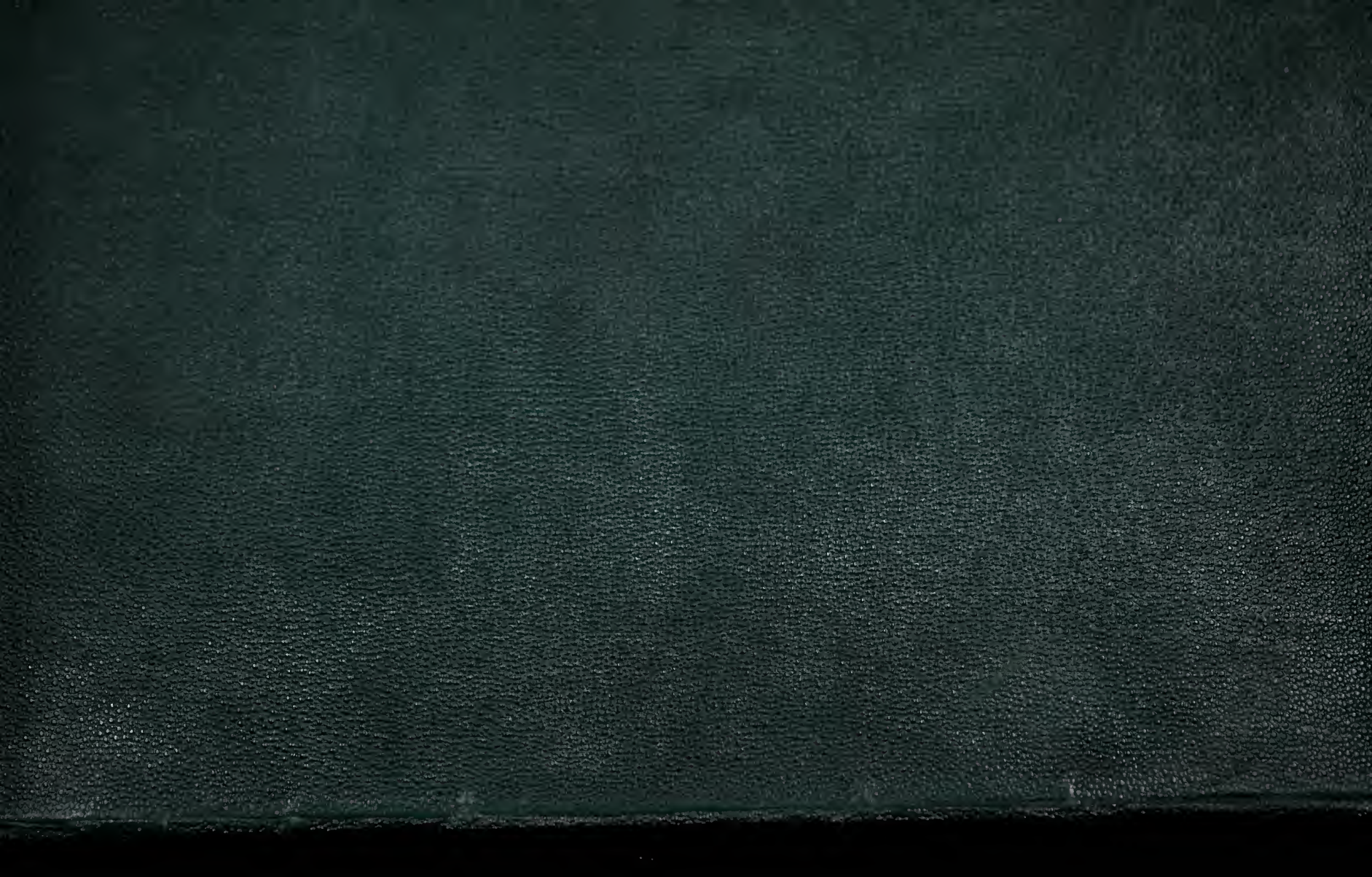




Digitized by the Internet Archive
in 2016

https://archive.org/details/journalofsociety31soci_0

JOURNAL

OF THE

SOCIETY OF ARTS.

VOLUME XXXI.

FROM NOVEMBER 17, 1882, TO NOVEMBER, 16, 1883.



LONDON:
PUBLISHED FOR THE SOCIETY BY GEORGE BELL AND SONS,
4, 5, & 6, YORK STREET, COVENT GARDEN

1883.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,565.] *FRIDAY, NOVEMBER* 17, 1882. [*Vol. XXXI.*

ONE-HUNDRED-AND-TWENTY-NINTH SESSION, 1882-83.

COUNCIL.

H.R.H. THE PRINCE OF WALES, K.G., *President of the Society.*

C. W. SIEMENS, D.C.L., LL.D., F.R.S., *Vice-Pres. and Chairman of the Council.*

H.R.H. THE DUKE OF EDINBURGH, K.G., *Vice-Pres.*
H.R.H. PRINCE LEOPOLD, DUKE OF ALBANY, K.G., *Vice-Pres.*
SIR RUTHERFORD ALCOCK, K.C.B., *Vice-Pres.*
SIR GEORGE BIRDWOOD, M.D., C.S.I., *Vice-Pres.*
SIR FREDERICK BRAMWELL, F.R.S., *Vice-Pres.*
SIR THOMAS BRASSEY, K.C.B., M.P., *Vice-Pres.*
ALFRED CARPMAEL.
ANDREW CASSELS.
LORD ALFRED S. CHURCHILL.
B. FRANCIS COBB, *Treasurer.*
SIR DANIEL COOPER, BART., K.C.M.G., *Vice-Pres.*
THOMAS RUSSELL CRAMPTON.
SIR PHILIP CUNLIFFE-OWEN, K.C.M.G., C.B., C.I.E., *Vice-Pres.*
HENRY DOULTON.
RIGHT HON. LORD OTHO AUGUSTUS FITZGERALD.
EDWARD FRANKLAND, D.C.L., F.R.S.
EARL GRANVILLE, K.G., F.R.S., *Vice-Pres.*
SIR JOHN HAWKSHAW, F.R.S., *Vice-Pres.*
ADMIRAL SIR EDWARD A. INGLEFIELD, C.B., F.R.S.
SIR FREDERICK LEIGHTON, P.R.A., *Vice-Pres.*
SIR JOHN LUBBOCK, BART., M.P., F.R.S., *Vice-Pres.*
DUKE OF MARLBOROUGH, K.G., *Vice-Pres.*
GEORGE MATTHEY, F.R.S.
ADMIRAL SIR F. W. NICOLSON, BART., C.B.
W. H. PERKIN, F.R.S., *Vice-Pres.*
LOFTUS PERKINS.
W. H. PREECE, F.R.S.
LORD REAY, *Vice-Pres.*
B. W. RICHARDSON, M.A., M.D., F.R.S., *Vice-Pres.*
OWEN ROBERTS, M.A., F.S.A., *Treasurer.*
EARL SPENCER, K.G., *Vice-Pres.*
WILLIAM SPOTTISWOODE, LL.D., P.R.S., *Vice-Pres.*
RT. HON. JAMES STANSFELD, M.P., *Vice-Pres.*
DUKE OF SUTHERLAND, K.G., F.R.S., *Vice-Pres.*
SIR RICHARD TEMPLE, Bart., G.C.S.I., C.I.E., D.C.L., *Vice-Pres.*

SECRETARY.
H. TRUEMAN WOOD, B.A.

ASSISTANT SECRETARY.
HENRY B. WHEATLEY, F.S.A.

ACCOUNTANT.
HOWARD H. ROOM.

AUDITOR.
J. OLDFIELD CHADWICK.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Twenty-Ninth Session of the Society was held on Wednesday, the 15th November, when the Opening Address was delivered by CHARLES WILLIAM SIEMENS, D.C.L., LL.D., F.R.S., Chairman of the Council. Previous to Christmas there will be Five Ordinary Meetings, when papers will be read by Dr. Hopkinson, Sir Frederick Bramwell, F.R.S., Mr. W. A. Gibbs, Mr. W. H. Preece, and Mr. P. L. Simmonds.

ORDINARY MEETINGS.

Wednesday evenings at Eight o'clock. The following dates are now fixed, and members are requested to note the alterations that have been made in the list:—

November 22.—J. HOPKINSON, D.Sc., F.R.S., "Ice-making and Refrigerating." Dr. SIEMENS, F.R.S., Chairman of Council, will preside.
,, 29.—SIR FREDERICK BRAMWELL, F.R.S., "Some Points in the Practice of the American Patent Office."
December 6.—WILLIAM A. GIBBS, "The Artificial Drying of Crops,"
,, 13.—W. H. PREECE, F.R.S., "Electrical Exhibitions."
,, 20.—P. L. SIMMONDS, "The Utilisation of Waste. A Quarter of a Century's Progress."

For Meetings after Christmas:—

W. K. BURTON, "The Sanitary Inspection of Houses."
J. H. EVANS, "The Modern Lathe."
CAPTAIN J. H. COLOMB, R.N., "Collisions at Sea."
A. J. HIPKINS, "The History of the Pianoforte."
C. F. CROSS, F.C.S., "Technical Aspects of Lignification."
W. N. HARTLEY, F.R.S.E., "Self-purification of River Waters."
JAMES J. DOBBIE, D.Sc., and JOHN HUTCHINSON, "On The Application of Electrolysis to Bleaching and Printing."
D. PIDGEON, "Recent Improvements in Agricultural Machinery."

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 30; February 27; March 20; April 3; May 1, 29.

APPLIED CHEMISTRY AND PHYSICS SECTION.

The meetings of this Section will take place on the following Thursday Evenings, at Eight o'clock:—

January 25; February 22; March 8; April 12, 26; May 24.

INDIAN SECTION.

The meetings of this Section will take place on the following Friday Evenings, at Eight o'clock:—

February 16; March 2; April 6, 20; May 4, 25.

CANTOR LECTURES.

The First Course will be on "Dynamo-Electric Machinery." By Prof. SILVANUS P. THOMPSON, D.Sc.

Lecture I.—The Dynamo in Theory.
Lecture II.—The Dynamo in Practice.
Lecture III.—The Dynamo as a Motor.

The Second Course will be on "Solid and Liquid Illuminating Agents." By LEOPOLD FIELD.

The Third Course will be on "The Decorative Treatment of Metal in Architecture." By GEORGE H. BIRCH.

The Fourth Course will be on "The Transmission of Energy." By OSBORNE REYNOLDS, M.A., F.R.S., Professor of Engineering at Owens College, Manchester.

The Fifth Course will be on "Secondary Batteries." By Prof. OLIVER J. LODGE, M.A., D.Sc.

JUVENILE LECTURES.

The two Juvenile Lectures will be by PROF. HENRY NOTTIDGE MOSELEY, M.A., F.R.S., on "The Inhabitants of the Ocean." The dates for these are Wednesday evenings, the 3rd and 10th January. The Lectures will commence at 7 o'clock. Special tickets will be issued for these Lectures.

PROCEEDINGS OF THE SOCIETY.

CHARTER.—THE SOCIETY OF ARTS was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom; and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country."

THE SESSION.—The Session commences in November, and ends in June. The number of Meetings held during the Session amounts to between 70 and 80.

ORDINARY MEETINGS.—At the Wednesday Evening Meetings during the Session papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

FOREIGN AND COLONIAL SECTION.—This Section was formed in 1874, under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies, and with Foreign Countries. Six or more Meetings are held during the Session.

APPLIED CHEMISTRY AND PHYSICS SECTION.—This Section was formed in 1874, for the discussion of subjects connected with Practical Chemistry and its applications to the Arts and Manufactures. It was enlarged in 1879, so as to include the consideration of subjects connected also with the Applications of Physical Science to the Arts. Six or more Meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are Three or more Courses every Session, and each course consists generally of from Three to Six Lectures.

ADDITIONAL LECTURES.—Special Courses of Lectures are occasionally given.

JUVENILE LECTURES.—A short Course of Lectures, suited for a Juvenile audience, is delivered to the Children of Members during the Christmas Holidays.

ADMISSION TO MEETINGS.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets are issued.

JOURNAL OF THE SOCIETY OF ARTS.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

EXAMINATIONS.—Examinations are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal divisions of a Commercial Education, Sanitary Knowledge, Political and Domestic Economy, and Music. A Programme, containing detailed information abont the Examinations, can be had on application to the Secretary.

LIBRARY AND READING-ROOM.—The Library and Reading-room are open to Members, who are also entitled to borrow books.

CONVERSAZIONI are held, to which the Members are invited, each Member receiving a card for himself and a Lady.

MEMBERSHIP.

The Society numbers at present between three and four thousand Members. The Annual Subscription is Two Guineas, or a Life Subscription of Twenty Guineas may be paid.

Every Member whose subscription is not in arrear is entitled :—

To be present at the Evening Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.

To be present and vote at all General Meetings of the Society.

To be present at the Cantor and other Lectures, and to introduce one visitor.

To have personal free admissions to all Exhibitions held by the Society at its house in the Adelphi,

To be present at all the Society's *Conversazioni*.

To receive a copy of the Weekly *Journal* published by the Society.

To the use of the Library and Reading-room.

Candidates for Membership are proposed by three Members, one of whom, at least, must sign on personal knowledge ; or are nominated by the Council. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day immediately preceding election ; or a sum of Twenty Guineas in lieu of all further contributions, may be paid.

All subscriptions should be paid to the Secretary, H. T. Wood, and all Cheques or Post-office Orders should be crossed " Coutts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C.

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1882-83. It is issued subject to any necessary alterations:—

NOVEMBER, 1882.			DECEMBER, 1882.			JANUARY, 1883.			FEBRUARY, 1883.		
1	W		1	F		1	M		1	Th	
2	Th		2	S		2	Tu		2	F	
3	F		3	S		3	W	Juvenile Lecture 1	3	S	
4	S		4	M	Cantor Lecture I. 1	4	Th		4	S	
5	S		5	Tu		5	F		5	M	Cantor Lecture II. 2
6	M		6	W	Ordinary Meeting	6	S		6	Tu	
7	Tu		7	Th		7	S		7	W	Ordinary Meeting
8	W		8	F		8	M		8	Th	
9	Th		9	S		9	Tu		9	F	
10	F		10	S		10	W	Juvenile Lecture 2	10	S	
11	S		11	M	Cantor Lecture I. 2	11	Th		11	S	
12	S		12	Tu		12	F		12	M	Cantor Lecture II. 3
13	M		13	W	Ordinary Meeting	13	S		13	Tu	
14	Tu		14	Th		14	S		14	W	Ordinary Meeting
15	W	Ordinary Meeting	15	F		15	M		15	Th	
16	Th	(Opening Meeting	16	S		16	Tu		16	F	Indian Section
17	F	of the Session)	17	S		17	W	Ordinary Meeting	17	S	
18	S		18	M	Cantor Lecture I. 3	18	Th		18	S	
19	S		19	Tu		19	F		19	M	Cantor Lecture II. 4
20	M		20	W	Ordinary Meeting	20	S		20	Tu	
21	Tu		21	Th		21	S		21	W	Ordinary Meeting
22	W	Ordinary Meeting	22	F		22	M		22	Th	Chem. & Phys. Sec.
23	Th		23	S		23	Tu		23	F	
24	F		24	S		24	W	Ordinary Meeting	24	S	
25	S		25	M	Christmas Day	25	Th	Chem. & Phys. Sec.	25	S	
26	S		26	Tu	Bank Holiday	26	F		26	M	Cantor Lecture II. 5
27	M		27	W		27	S		27	Tu	For. & Col. Section
28	Tu		28	Th		28	S		28	W	Ordinary Meeting
29	W	Ordinary Meeting	29	F		29	M	Cantor Lecture II. 1			
30	Th		30	S		30	Tu	For. & Col. Section			
			31	S		31	W	Ordinary Meeting			

MARCH, 1883.			APRIL, 1883.			MAY, 1883.			JUNE, 1883.		
1	Th		1	S		1	Tu	For. & Col. Section	1	F	
2	F	Indian Section	2	M	Cantor Lecture III. 1	2	W	Ordinary Meeting	2	S	
3	S		3	Tu	For. & Col. Section	3	Th		3	S	
4	S		4	W	Ordinary Meeting	4	F	Indian Section	4	M	
5	M	Cantor Lecture II. 6	5	Th		5	S		5	Tu	
6	Tu		6	F	Indian Section	6	S		6	W	Conversazione at the
7	W	Ordinary Meeting	7	S		7	M	Cantor Lecture IV. 3	7	Th	South Kensington
8	Th	Chem. & Phys. Sec.	8	S		8	Tu		8	F	Museum
9	F		9	M	Cantor Lecture III. 2	9	W	Ordinary Meeting	9	S	
10	S		10	Tu		10	Th		10	S	
11	S		11	W	Ordinary Meeting	11	F		11	M	
12	M		12	Th	Chem. & Phys. Sec.	12	S		12	Tu	
13	Tu		13	F		13	S	Whit Sunday.	13	W	
14	W	Ordinary Meeting	14	S		14	M	Bank Holiday	14	Th	
15	Th		15	S		15	Tu		15	F	
16	F		16	M	Cantor Lecture III. 3	16	W	Ordinary Meeting	16	S	
17	S		17	Tu		17	Th		17	S	
18	S		18	W	Ordinary Meeting	18	F		18	M	
19	M		19	Th		19	S		19	Tu	
20	Tu	For. & Col. Section	20	F	Indian Section	20	S	Cantor Lecture V. 1	20	W	
21	W		21	S		21	M		21	Th	
22	Th		22	S		22	Tu		22	F	
23	F	Good Friday	23	M	Cantor Lecture IV. 1	23	W	Ordinary Meeting	23	S	
24	S		24	Tu		24	Th	Chem. & Phys. Sec.	24	S	
25	S	Easter Sunday	25	W	Ordinary Meeting	25	F	Indian Section	25	M	
26	M	Bank Holiday	26	Th	Chem. & Phys. Sec.	26	S		26	Tu	
27	Tu		27	F		27	S		27	W	Annual General
28	W		28	S		28	M	Cantor Lecture V. 2	28	Th	Meeting
29	Th		29	S		29	Tu	For. & Col. Section	29	F	
30	F		30	M	Cantor Lecture IV. 2	30	W	Ordinary Meeting	30	S	
31	S					31	Th				

The chair will be taken at eight o'clock at each of the above meetings, except the Annual General Meeting and the Juvenile Lectures.

The Annual General Meeting will be held at four o'clock.

The Juvenile Lectures will be given at seven o'clock.

NOTICES.

THE SOCIETY'S HOUSE.

During the recess, the Society's house has undergone a thorough renovation, both within and without. The stone work of the front has been cleaned and the brickwork re-pointed, so that the architectural elevation is seen to greater advantage than it has been for many years. The meeting room, the library, and staircase have been entirely redecorated, and the seats have been improved and re-covered.

In addition to the decoration, a new system of ventilation has been introduced, which it is hoped will have the effect of keeping the meeting room always at an agreeable and equable temperature. All the fresh air that enters the room is heated in its passage from the outside.

Arrangements have also been made for the use of the electric light. At present, the Great Room is lighted by Edison's incandescence lamps suspended by electroliers from the ceiling (lent by Messrs. Verity), and also ranged round the walls of the room. The lamps are worked by means of a Siemens dynamo-machine, and one of Messrs. Crossley's gas-engines, both presented to the Society by some past and present members of the Council. The Great Room was lighted by these lamps for the first time on the occasion of the opening meeting on Wednesday the, 15th inst.

LABEL FOR PLANTS.

The Council, on the recommendation of the judges in the late competition of plant labels, are prepared to renew the offer of a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

In addition to the prize offered by Mr. Wilson, a prize of five guineas has been placed at the disposal of the Council of the Society by Mr. E. G. Loder, for the best permanent border label suitable for private gardens, the cost of which should not exceed £4 per thousand.

Both awards will be made on the recommendation of the Committee appointed for the purpose by the Council.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society, not later than the 1st of May, 1883.

The Council reserve to themselves the right of withholding the medal and prizes offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

UNION OF INSTITUTIONS.

The following Institutions have been received into Union since the last announcement:—

Wilton Art Classes, Wilton, Salisbury.

Proceedings of the Society

FIRST ORDINARY MEETING.

Wednesday, November 15th, 1882; CHARLES WILLIAM SIEMENS, D.C.L., LL.D., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Annabale, William, 3, Brighton-place, Govan, Glasgow.

Ashbee, Henry Spencer, 46, Upper Bedford-place, W.C.

Aylesbury, Captain Thomas William, The Elms, Sutton, Surrey.

Benvenuti, Fortuné François, Gore-house, Gore-terrace, Swansea, South Wales.

Borradaile, Thomas Salkeld, 7, Union-court, Old Broad-street, E.C., and Nya Ghur, Surbiton, Surrey.

Boulton, Samuel Bagster, 64, Cannon-street, E.C., and Copped-hall, Totteridge, Herts.

Brown, Richard, 12, St. James's-road, Liverpool.

Brougham, Hon. Reginald, British Electric Light Company, Heddon-street, Regent-street, W.

Carpenter, William Lant, B.A., B.Sc., F.C.S., 36, Craven-park, Harlesden, N.W.

Cates, Arthur, 12, York-terrace, Regent's-park, N.W.

Cathcart, Charles H., Cressingham-grove, Sutton, Surrey.

Church, Henry J., H.B.M. Pro-Consul, Halsörn, Vessen, Nordland, Norway.

Clarke, Stephenson, Croydon-lodge, Croydon.

Cooke, John, Howe-villa, Richmond, Yorkshire.
Davis, Thomas Sebastian, 3, Lansfield-terrace, South Lambeth-road, S.W.
Dearnaley, Irvine, Handel-place, Ashton-under-Lyne.
De Soyres, Francis Johnston, 6, Arlington-villas, Clifton, Bristol.
Dorman, Thomas Phipps, Billing-road, Northampton.
Durrant, Edmund, High-street, Chelmsford.
Elliott, Thomas William, 26, Tavistock-square, W.C.
Farrer, Thomas Henry, Abinger-hall, Dorking.
Formby, John, Heaves, Milnthorpe, Westmoreland.
Forster, Stuart, Binfield-house, Bracknell, Berks.
Fosbery, Lieut.-Colonel George Vincent, Upton-house, Bitton, near Bristol.
Gaddes, Thomas, 46, Seymour-street, Portman-square, W.
Godwin, James, 61, Stoke Newington-road, N., and Leadenhall Market, E.C.
Gough, Mrs., Willenhall, near Wolverhampton.
Gregory, Edward, 101, Guilford-street, Russell-square, W.C.
Hallett, John Harry, 120, Powell's-place, Bute Docks, Cardiff.
Hamilton, Frederic Adam, Halifax, Nova Scotia.
Harding, Thomas Richards, Tower Works, Globe-road, Leeds.
Hawker, Lieut. E. C. Tyrell, R.E., H.M.S. *Hood*, Chatham.
Herman, Henry, 5, Keppel-street, W.C.
Hopkinson, John, D.Sc., M.A., F.R.S., 4, Westminster-chambers, S.W.
Howell, Jonathan, Birnam-villas, 10, Tollington-park, N.
Jensen, Jens, 17, Fairfield-road, Birkenhead.
Kemp, Mrs. Widmore, Taunton, Somerset.
Kitching, John, Oaklands, Kingston-hill, Surrey, and Elm Field, Darlington.
Lake, Henry Harris, 8, Southampton-buildings, W.C.
Morris, James, D.Sc., Bourtree-hill, Uddingston, Lanarkshire.
Moss, Henry, Parmiter's School, E.
Nightingale, James E., Wilton, Salisbury.
Park, William Charles Cunningham, 25, Lime-street, E.C.
Pielsticker, C. M., 5, Sidney-terrace, Kilburn, N.W.
Reckenzaun, Anthony, Leytonstone, Essex.
Reid, Walter Francis, F.C.S., Stowmarket.
Routh, Thomas Alfred, 52, Beaumont-street, Marylebone, W.
Ryall, William Bolitho, 24, Warwick-lane, E.C.
Ryan, John, B.A., Warwick-house, Maida-vale, W.
Schofield, Christopher James, Whalley-range, Manchester.
Sheldon, E. L., 13, Clement's-lane, Lombard-st., E.C.
Simon, Henry Gustavus, Darwin-house, Didsbury.
Simonds, William Turner, Ivy-house, Skirleck Quarter, Boston, Lincolnshire.
Stafford, Marquis of, M.P., Stafford-house, St. James's, S.W.
Teague, William, jun., Pool, Cornwall.
Vercy, Arthur, Dover.
Vesey, Arthur Henry, The Grange, Knockholt, Sevenoaks
Watson, Joseph, the Attorney-General's-chambers, New-court, Temple, E.C.
Watt, William, 20, Grafton-street, W.C.
Wigg, Charles, Halton-lodge, Runcorn, near Liverpool.
Wing, Thomas W., 83, Piccadilly, W.
Wrench, Robert, Gilamont, Maple-road, Surbiton.
Wright, Frank, 128, Osborne-road, Forest-gate, E., and 80, Gray's-inn-road, W.C.

The CHAIRMAN delivered the following

ADDRESS.

Having received the honour of being elected Chairman of the Council of the Society of Arts for the ensuing year, the duty devolves upon me of opening the coming Session with some introductory remarks.

Only a few months have elapsed since I was called upon to deliver a presidential address to the British Association at Southampton, and it may be reasonably supposed that I then exhausted my stock of accumulated thought and observation regarding the present development of science, both abstract and applied; that, in fact, I come before you, to use a popular phrase, pretty well pumped dry. And yet so large is the field of modern science and industry, that, notwithstanding the good opportunity given me at Southampton, I could there do only scanty justice to comparatively few of the branches of modern progress, and had to curtail, or entirely omit, reference to others, upon which I should otherwise have wished to dwell.

There is this essential difference between the British Association and the Society of Arts, that the former can only take an annual survey of the progress of science, and must then confide to individuals, or to committees, specific inquiries, to be reported upon to the different sections at subsequent meetings; whereas the Society of Arts, with its 3,450 permanent members, its ninety-five associated societies, spread throughout the length and breadth of the country, its permanent building, its well-conducted *Journal*, its almost daily meetings and lectures, extending over six months of the year, possesses exceptionally favourable opportunities of following up questions of industrial progress to the point of their practical accomplishment.

In glancing back upon its history during the 128 years of its existence, we discover that the Society of Arts was the first institu-

tion to introduce science into the industrial arts; it was through the Society of Arts and its illustrious Past President, the late Prince Consort, that the first Universal Exhibition was proposed, and brought to a successful issue in 1851; and it is due to the same Society, supported on all important occasions by its present President, the Prince of Wales, that so many important changes in our educational and industrial institutions have been inaugurated, too numerous to be referred to specifically on the present occasion.

Amongst the practical questions that now chiefly occupy public attention are those of Electric Lighting, and of the transmission of force by electricity. These together form a subject which has occupied my attention and that of my brothers for a great number of years, and upon which I may consequently be expected to dwell on the present occasion, considering that at Southampton I could deal only with some purely scientific considerations involved in this important subject.

I need hardly remind you that electric lighting, viewed as a physical experiment, has been known to us since the early part of the present century, and that many attempts have, from time to time been made to promote its application. Two principal difficulties have stood in the way of its practical introduction, viz., the great cost of producing an electric current so long as chemical means had to be resorted to, and the mechanical difficulty of constructing electric lamps capable of sustaining, with steadiness, prolonged effects.

The dynamo-machine, which enables us to convert mechanical into electrical force, purely and simply, has very effectually disposed of the former difficulty, inasmuch as a properly conceived and well constructed machine of this character converts more than ninety per cent. of the mechanical force imparted to it into electricity, ninety per cent. again of which may be re-converted into mechanical force at a moderate distance. The margin of loss, therefore, does not exceed twenty per cent., excluding purely mechanical losses, and this is quite capable of being further reduced to some extent by improved modes of construction; but it results from these figures that no great step in advance can be looked for in this direction. The dynamo-machine presents the great advantage of simplicity over steam or other power-transmitting engines; it has but one working part, namely, a shaft which, revolving in a pair of bearings, carries a coil or coils of wire admitting of perfect balancing. Frictional resistance is thus reduced to an absolute minimum, and no allowance has to be made for loss by condensation, or badly fitting pistons, stuffing boxes, or valves, or for the jerking action due to oscillating weights. The materials composing the machine, namely, soft iron and copper wire, undergo no deterioration or change by continuous working, and the depreciation of value is therefore a minimum, except where currents of exceptionally high potential are used, which appear to render the copper wire brittle.

The essential points to be attended to in the conception of the dynamo-machine, are the prevention of induced currents in the iron, and the placing of the wire in such position as to make the whole of it effective for the production of outward current. These principles, which have been clearly established by the labours of comparatively few workers in applied science, admit of being carried out in an almost infinite variety of constructive forms, for each of which may be claimed some real or imaginary merits regarding questions of convenience or cost of production.

For many years after the principles involved in the construction of dynamo-machines had been made known, little general interest was manifested in their favour, and few were the forms of construction offered for public use. The essential feature involved in the dynamo-machine, the Siemens armature (1856), the Pacinotti ring (1861), and the self-exciting principle (1867), were published by their authors for the pure scientific interest attached to them, without being made subject matter of letters patent, which circumstance appears to have had the contrary effect of what might have been expected, in that it has retarded the introduction of this class of electrical machine, because no person or firm had a sufficient commercial interest to undertake the large expenditure which must neccessarily be incurred in reducing a first conception into a practical shape. Great credit is due to Monsieur Gramme for taking the initiative in the practical introduction of dynamo-machines embodying those principles; but when, five years ago, I ventured to predict for the dynamo-electric current a great practical future, as a means of transmitting power to a distance, those views were still looked upon as more or less chimerical. A few striking examples of what could be practically effected by the dynamo-electric current, such as the illumination of the Place de l'Opera, Paris, the occasional exhibition of powerful arc

lights, and their adoption for military and light-house purposes, but especially the gradual accomplishment of the much desired lamp by incandescence in vacuum, gave rise to a somewhat sudden reversion of public feeling; and you may remember the scare at the Stock Exchange, affecting the value of gas shares, which ensued in 1878, when the accomplishment of the sub-division of the electric light by incandescent wire was first announced, somewhat prematurely, through the Atlantic cable.

From this time forward electric lighting has been attracting more and more public attention, until the brilliant displays at the exhibition of Paris, and at the Crystal Palace last year, served to excite public interest, to an extraordinary degree. New companies for the purpose of introducing electric light and power have been announced almost daily, whose claims to public attention as investments were based in some cases upon only very slight modifications of well-known forms of dynamo-machines, of arc regulators, or of incandescent carbon lights, the merits of which rested rather upon anticipations than upon any scientific or practical proof. These arrangements were supposed to be of such superlative merit that gas and other illuminants must soon be matters simply of history, and hence arose great speculative excitement. It should be borne in mind, however, that any great technical advance is necessarily the work of time and serious labour, and that when accomplished, it is generally found that, so far from injuring existing industries, it calls additional ones into existence, to supply new demands, and thus gives rise to an increase in the sum total of our resources. It is, therefore, reasonable to expect that, side by side with the introduction of the new illuminant, gas lighting will go on improving and extending, although the advantage of electric light for many applications, such as the lighting of public halls and warehouses, of our drawing-rooms and dining-rooms, our passenger steamers, our docks and harbours, are so evident, that its advent may be looked upon as a matter of certainty.

Our Legislature has not been slow in recognising the importance of the new illuminant. In 1879, a Select Committee of the House of Commons instituted a careful inquiry into its nature and probable cost, with a view to legislation, and the conclusions at which they arrived were, I consider, the best that could have been laid down. They advised that applications should be encouraged tentatively by the granting of permissive Bills, and this policy has given rise to the Electric Lighting Bill, 1882, promoted by Mr. Chamberlain, the President of the Board of Trade, regarding which much controversy has arisen. It could, indeed, hardly be expected that any act of legislation upon this subject could give universal satisfaction, because, while there are many believers in gas who would gladly oppose any measure likely to favour the progress of the rival illuminant, and others who wish to see it monopolised, either by local authorities, or by large financial corporations, there are others again who would throw the doors open so wide as to enable almost all comers to interfere with the public thoroughfares, for the establishment of conducting wires, without let public or hindrance.

The law as now established takes, I consider, a medium course between these diverging opinions, and, if properly interpreted, will protect, I believe, all legitimate interests, without impeding the healthy growth of establishments for the distribution of electric energy for lighting and for the transmission of power. Any firm or lighting company may, by application to the local authorities, obtain leave to place electric conductors below public thoroughfares, subject to such conditions as may be mutually agreed upon, the term of such license being limited to seven years; or an application may be made to the Board of Trade for a provisional order to the same effect, which, when sanctioned by Parliament, secures a right of occupation for twenty-one years. The license offers the advantage of cheapness, and may be regarded as a purely tentative measure, to enable the firm or company to prove the value of their plant. If this is fairly established, the license would in all probability be affirmed, either by an engagement for its prolongation from time to time, or by a provisional order, which would, in that case, be obtained by joint application of the contractor and the local authority. At the time of expiration of the provisional order, a right of pre-emption is accorded to the local authority, against which it has been objected with much force, by so competent an authority as Sir Frederick Bramwell, that the conditions of purchase laid down are not such as fairly to remunerate the contracting companies for their expenditure and risk, and that the power of purchase would inevitably induce the parochial bodies to become mere trading associations. But while admitting the undesirability of such a consummation, I cannot help

thinking that it was necessary to put some term to contracts entered into with speculative bodies at a time when the true value of electric energy, and the best conditions under which it should be applied, are still very imperfectly understood. The supply of electric energy, particularly in its application to transmission of power, is a matter simply of commercial demand and supply, which need not partake of the character of a large monopoly, similar to gas and water supply, and which may therefore be safely left in the hands of individuals, or of local associations, subject to a certain control for the protection of public interests. At the termination of the period of the provisional order, the contract may be renewed upon such terms and conditions as may at that time appear just and reasonable to Parliament, under whose authority the Board of Trade will be empowered to effect such renewal.

Complaints appear almost daily in the public papers, to the effect that townships refuse their assent to applications by electric light companies for provisional orders; but it may be surmised that many of these applications are of a more or less speculative character, the object being to secure monopolies for eventual use or sale, under which circumstances the authorities are clearly justified in witholding their assent; and no licenses or provisional orders should indeed be granted, I consider, unless the applicants can give assurance of being able and willing to carry out the work within a reasonable time. But there are technical questions involved which are not yet sufficiently well understood to admit of immediate operations upon a large scale.

Attention has been very properly called to the great divergence in the opinions expressed by scientific men regarding the area that each lighting district should comprise, the capital required to light such an area, and the amount of electric tension that should be allowed in the conductors. In the case of gas supply, the works are necessarily situated in the outskirts of the town, on account of the nuisance this manufacture occasions to the immediate neighbourhood; and, therefore, gas supply must range over a large area. It would be possible, no doubt, to deal with electricity on a similar basis, to establish electrical mains in the shape of copper rods of great thickness, with branches diverging from them in all directions; but the question to be considered is, whether such an imitative course is desirable on account either of relative expense or of facility of working. My own opinion, based upon considerable practical experience and thought devoted to the subject, is decidedly adverse to such a plan. In my evidence before the Parliamentary Committee, I limited the desirable area of an electric district in densely-populated towns to a quarter of a square mile, and estimated the cost of the necessary establishment of engines, dynamo-machines, and conductors, at £100,000, while other witnesses held that areas from one to four square miles could be worked advantageously from one centre, and at a cost not exceeding materially the figure I had given. These discrepancies do not necessarily imply wide differences in the estimated cost of each machine or electric light, inasmuch as such estimates are necessarily based upon various assumptions regarding the number of houses and of public buildings comprised in such a district, and the amount of light to be apportioned to each, but I still maintain my preference for small districts.

By way of illustration, let us take the parish of St. James's, near at hand, a district not more densely populated than other equal areas within the metropolis, although comprising, perhaps, a greater number of public buildings. Its population, according to the preliminary report of the census taken on the 4th April, 1881, was 29,865, it contains 3,018 inhabited houses, and its area is 784,000 square yards, or slightly above a quarter of a square mile.

To light a comfortable house of moderate dimensions in all its parts, to the exclusion of gas, oil, or candles, would require about 100 incandescence lights (or, if I may suggest a more euphonious expression, glow-lights) of from 15 to 18-candle power each, that being, for instance, the number of Swan lights employed by Sir William Thomson in lighting his house at Glasgow University. Eleven-horse power would be required to excite this number of incandescence lights, and at this rate the parish of St. James's would require $3{,}018 \times 11 = 33{,}200$-horse power to work it. It may be fairly objected, however, that there are many houses in the parish much below the standard here referred to, but, on the other hand, there are 600 of them with shops on the ground floor, involving larger requirements. Nor does this estimate provide for the large consumption of electric energy that would take place in lighting the eleven churches, eighteen club-houses, nine concert halls, three theatres, besides numerous hotels, restaurants, and lecture halls. A theatre of moderate dimensions, such as the Savoy Theatre, has been proved by experience to require 1,200 incan-

descence lights, representing an expenditure of 133-horse power; and about one-half that power would have to be set aside for each of the other public buildings here mentioned, constituting an agregate of 2,926-horse power; nor does this general estimate comprise street lighting, and to light the six and a-half miles of principal streets of the parish with electric light, would require, per mile, thirty-five arc lights of 350-candle power each, or a total of 227 lights. This, taken at the rate of 0·8-horse power per light, represents a further requirement of 182 horse-power, making a total of 3,108 horse-power, for purposes independent of house lighting, being equivalent to one-horse power per inhabited house, and bringing the total requirements up to 109 lights = 12-horse power per house.

I do not, however, agree with those who expect that gas lighting will be entirely superseded, but have, on the contrary, always maintained that the electric light, while possessing great and peculiar advantages for lighting our principal rooms, halls, warehouses, &c., owing to its brilliancy, and more particularly to its non-interference with the healthful condition of the atmosphere, will leave ample room for the development of the former, which is susceptible of great improvement, and is likely to hold its own for the ordinary lighting up of our streets and dwellings.

Assuming, therefore, that the bulk of domestic lighting remains to the gas companies, and that the electric light is introduced into private houses, only, at the rate of, say twelve incandescence lights per house, the parish of St. James's would have to be provided with electric energy sufficient to work (9 + 12) 3,018 = 63,378 lights = 7,042-horse power effective; this is equal to about one-fourth the total lighting power required, taking into account that the total number of lights that have to be provided for a house are not all used at one and the same time. No allowance is made in this estimate for the transmission of power, which, in course of time, will form a very large application of electric energy; but considering that power will be required mostly in the day time, when light is not needed, a material increase in plant will not be necessary for that purpose.

In order to minimise the length and thickness of the electric conductor, it would be important to establish the source of power, as nearly as may be, in the centre of the parish, and the position that suggests itself to my mind is that of Golden-square. If the unoccupied area of this square, representing 2,500 square yards, was excavated to a depth of twenty-five feet, and then arched over so as to re-establish the present ground level, a suitable covered space would be provided for the boilers, engines, and dynamo-machines, without causing obstruction or public annoyance; the only erection above the surface would be the chimney, which, if made monumental in form, might be placed in the centre of the square, and be combined with shafts for ventilating the subterranean chamber, care being taken of course to avoid smoke by insuring perfect combustion of the fuel used. The cost of such a chamber, of engine power, and of dynamo-machines, capable of converting that power into electric energy, I estimate at £140,000. To this expense would have to be added that of providing and laying the conductors, together with the switches, current regulators, and arrangements for testing the insulation of the wire.

The cost and dimensions of the conductors would depend upon their length, and the electromotive force to be allowed. The latter would no doubt be limited, by the authorities, to the point at which contact of the two conductors with the human frame would not produce injurious effects, or say to 200 volts, except for street lighting, for which purpose a higher tension is admissible. In considering the proper size of conductor to be used in any given installation, two principal factors have to be taken into account; first, the charge for interest and depreciation on the original cost of a unit length of the conductor; and, secondly, the cost of the electrical energy lost through the resistance of a unit of length. The sum of these two, which may be regarded as the cost of conveyance of electricity, is clearly least, as Sir William Thomson pointed out some time ago, when the two components are equal. This, then, is the principle on which the size of a conductor should be determined.

From the experience of large installations, I consider that electricity can, roughly speaking, be produced in London at a cost of about one shilling per 10,000 Ampère-Volts or Watts (746 Watts being equal to 1-horse power) for an hour. Hence, assuming that each set of four incandescence lamps in series (such as Swan's, but for which may be substituted a smaller number of higher resistance and higher luminosity) requires 200 volts electromotive force, and 60 Watts for their efficient working, the total current required for 64,000 such lights is 19,200 ampères, and the cost of the electric

energy lost by this current in passing through $\frac{1}{100}$th of an ohm resistance, is £16 per hour.

The resistance of a copper bar one quarter of a mile in length, and one square inch in section, is very nearly $\frac{1}{100}$th of an ohm, and the weight is about 2⅓ tons. Assuming, then, the price of insulated copper conductor at £90 per ton, and the rate of interest and depreciation at 7½ per cent., the charge per hour of the above conductor, when used eight hours per day, is 1½d. Hence, following the principle I have stated above, the proper size of conductor to use for an installation of the magnitude I have supposed, would be one of 48·29 inches section, or a round rod eight inches diameter.

If the mean distance of the lamps from the station be assumed as 350 yards, the weight of copper used in the complete system of conductors would be nearly 168 tons, and its cost £15,120. To this must be added the cost of iron pipes, for carrying the conductors underground, and of testing boxes, and labour in placing them. Four pipes, of 10 inch diameter each, would have to proceed in different directions from the central station, each containing sixteen separate conductors of one inch diameter, and separately insulated, each of them supplying a sub-district of 1,000 lights. The total cost of establishing these conductors may be taken at £37,000, which brings up the total expenditure for central station and leads to £177,000. I assume the conductors to be placed underground, as I consider it quite inadmissible, both as regards permanency and public safety and convenience, to place them above ground, within the precincts of towns. With this expenditure, the parish of St. James's could be supplied with the electric light to the extent of about 25 per cent. of the total illuminating power required. To provide a larger per-centage of electric energy would increase the cost of establishment proportionately; and that of conductors, nearly in the square ratio of the increase of the district, unless the loss of energy by resistance is allowed to augment instead.

It may surprise uninitiated persons to be told that to supply a single parish with electric energy necessitates copper conductors of a collective area equal to a rod of eight inches in diameter; and how, it may be asked, will it be possible under such conditions to transmit the energy of waterfalls to distances of twenty or thirty miles, as has been suggested. It must indeed be admitted that the transmission of electric energy of such potential (200 volts) as is admissible in private dwellings would involve conductors of impracticable dimensions, and in order to transmit electrical energy to such distances, it is necessary to resort in the first place to an electric current of high tension. By increasing the tension from 200 to 1,200 volts the conductors may be reduced to one-sixth their area, and if we are content to lose a larger proportion of the energy obtained cheaply from a waterfall, we may effect a still greater reduction. A current of such high potential could not be introduced into houses for lighting purposes, but it could be passed through the coils of a secondary dynamo-machine, to give motion to another primary machine, producing currents of low potential to be distributed for general consumption. Or secondary batteries may be used to effect the conversion of currents of high into those of low potential, whichever means may be found the cheaper in first cost, in maintenance, and most economical of energy. It may be advisable to have several such relays of energy for great distances, the result of which would be a reduction of the size and cost of conductor at the expense of final effect, and the policy of the electrical engineer will, in such cases, have to be governed by the relative cost of the conductor, and of the power at its original source. If secondary batteries should become more permanent in their action than they are at the present time, they may be largely resorted to by consumers, to receive a charge of electrical energy during the day time, or the small hours of the night, when the central engine would otherwise be unemployed, and the advantage of resorting to these means will depend upon the relative first cost, and cost of working the secondary battery and the engine respectively. These questions are, however, outside the range of our present consideration.

The large aggregate of dwellings comprising the metropolis of London covers about seventy square miles, thirty of which may be taken to consist of parks, squares, and sparsely inhabited areas, which are not to be considered for our present purpose. The remaining forty square miles could be divided into say 140 districts, slightly exceeding a quarter of a square mile on the average, but containing each fully 3,000 houses, and a population similar to that of St. James's.

Assuming twenty of these districts to rank with the parish of St. James's (after deducting the 600 shops which I did not include in my estimate) as central districts, sixty to be residential districts, and sixty to

be comparatively poor neighbourhoods, and estimating the illuminating power required for these three classes in the proportion of 1 to ⅔ to ⅓, we should find that the total capital expenditure for supplying the metropolis with electric energy to the extent of 25 per cent. of the total lighting requirements would be—

20	×	177,000	=	£3,540,000
60	× ⅔ ×	177,000	=	£7,080,000
60	× ⅓ ×	177,000	=	£3,540,000
				£14,160,000

or say £14,000,000, without including lamps and internal fittings, and making an average capital expenditure of £100,000 per district.

To extend the same system over the towns of Great Britain, and Ireland would absorb a capital exceeding certainly £64,000,000, to which must be added £16,000,000 for lamps and internal fittings, making a total capital expenditure of £80,000,000. Some of us may live to see this realised, but to find such an amount of capital, and, what is more important, to find the manufacturing appliances to produce work representing this value of machinery and wire, must necessarily be the result of many years of technical development. If, therefore, we see that electric companies apply for provisional orders to supply electric energy, not only for every town throughout the country, but also for colonies, and for foreign parts, we are forced to the conclusion that their ambition is somewhat in excess of their power of performance; and that no provisional order should be granted except conditionally on the work being executed within a reasonable time, as without such a provision the powers granted may have the effect of retarding instead of advancing electric lighting, and of providing an undue encouragement to purely speculative operations.

The extension of a district beyond the quarter of a square mile limit, would necessitate an establishment of unwieldy dimensions, and the total cost of electric conductors per unit area would be materially increased; but independently of the consideration of cost, great public inconvenience would arise in consequence of the number and dimensions of the electric conductors, which could no longer be accommodated in narrow channels placed below the kerb stones, but would necessitate the construction of costly subways—veritable *cava electrica*.

The amount of the working charges of an establishment comprising the parish of St. James's would depend on the number of working hours in the day, and on the price of fuel per ton. Assuming the 64,000 lights to incandesce for six hours a day, the price of coal to be 20s. a ton, and the consumption 2 lbs. per effective horse power per hour, the annual charge under this head, taking 8 hours' firing, would amount to about £18,300, to which would have to be added for wages, repairs, and sundries, about £6,000; for interest, with depreciation at seven and a-half per cent., £13,300; and for general management say, £3,400; making a total annual charge of £41,000, or at the rate of 12s. 9½d. per incandescence lamp per annum. To this has to be added the cost of renewal of lamps, which may be taken at 5s. per lamp of 16 candles, lasting 1,200 hours, or to 9s. per annum, making a total of 21s. 9½d. per lamp for a year.

In comparing these results with the cost of gas lighting, we shall find that it takes five cubic feet of gas, in a good argand burner, to produce the same luminous effect, as one incandescence light of 16-candle power. In lighting such a burner every day, for six hours on the average, we obtain an annual gas consumption of 10,950 cubic feet, the value of which, taken at the rate of 2s. 8d. per thousand, represents an annual charge of 29s., showing that electric light by incandescence, when carried out on a large scale, is decidedly cheaper than gas lighting at present prices, and with the ordinary gas burners.

On the other hand, the cost of establishing gas works and mains of a capacity equal to 64,000 argand burners, would involve an expenditure not exceeding £80,000 as compared with £177,000 in the case of electricity; and it is thus shown that, although it is more costly to establish a given supply of illuminating power by electricity than gas, the former has the advantage as regards current cost of production.

It would not be safe, however, for the advocates of electric lighting to rely upon these figures as representing a permanent state of things. In calculating the cost of electric light, I have only allowed for depreciation and 5 per cent. interest upon capital expenditure, whereas gas companies are in the habit of dividing large dividends, and can afford to supply gas at a cheaper rate, by taking advantage of recent improvements in manufacturing operations, and of the ever increasing value of their by-products, including tar, coke, and ammoniacal liquor. Burners have, moreover, been recently devised by which the luminous effect for a given expenditure of gas can be nearly doubled

by purely mechanical arrangements, and the brilliancy of the light can be greatly improved.

On the other hand, electric lighting also may certainly be cheapened by resorting, to a greater extent than has been assumed, to arc lighting, which, though less agreeable than the incandescence (or glow) light for domestic purposes, can be produced at less than half the cost, and deserves on that account the preference for street lighting, and for large halls, in combination with incandescence lights. Lamps by incandescence may be produced hereafter at a lower cost, and of a more enduring character.

Considering the increasing public demand for improved illumination, it is not unreasonable to expect that the introduction of the electric light to the full extent here contemplated, would go hand-in-hand with an increasing consumption of gas for illuminating and for heating purposes, and the neck-to-neck competition between the representatives of the two systems of illumination which is likely to ensue, cannot fail to improve the quality, and to cheapen the supply of both, a competition which the consuming public can afford to watch with complacent self-satisfaction. Electricity must win the day, as the light of luxury; but gas will, at the same time, find an ever increasing application for the more humble purposes of diffusing light.

In my address to the British Association, I dwelt upon the capabilities and prospects of gas, both as an illuminant and as a heating agent, and I do not think that I was over sanguine in predicting for this combustible a future exceeding all present anticipations.

I showed that if supplied specially for the purpose, it would become not only the most convenient, but by far the cheapest form of fuel that can be delivered to our towns. Such a general supply of heating separately from illuminating gas, by collecting the two gases into separate holders during the process of distillation, would have the beneficial effects—

1st. Of giving to lighting gas a higher illuminating power.

2nd. Of relieving our towns of their most objectionable traffic, that in coal and ashes.

3rd. Of effecting the perfect cure of that bugbear of our winter existence—the smoke nuisance.

4th. Of largely increasing the production of those valuable by-products, tar, coke, and ammonia, the annual value of which already exceeds by nearly £3,000,000 that of the coal consumed in the gas works.

The late exhibitions have been beneficial in arousing public interest in favour of smoke abatement, and it is satisfactory to find that many persons, without being compelled to do so, are now introducing perfectly smokeless arrangements for their domestic and kitchen fires.

The Society of Arts, which for more than 100 years has given its attention to important questions regarding public health, comfort, and instruction would, in my opinion, be the proper body to examine thoroughly into the question of the supply and economical application of gas and electricity for the purposes of lighting, of power production and of heating. They would thus pave the way to such legislative reform as may be necessary to facilitate the introduction of a rational system.

If I can be instrumental in engaging the interest of the Society in these important questions, especially that of smoke prevention, I shall vacate this chair next year with the pleasing consciousness that my term of office has not been devoid of a practical result.

The CHAIRMAN then presented the following Medals and Prizes :—

The Society's Silver Medal for Papers read before the Society during the last Session :—

To Professor SILVANUS THOMPSON, D.Sc., for his paper on "Storage of Electricity."

To J. EMERSON DOWSON, for his paper on "The Production and Use of Gas for Purposes of Heating and Motive Power."

To Colonel G. F. PEARSON, for his paper on "The Teaching of Forestry."

To Professor BARFF, M.A., for his paper on "A New Antiseptic Compound, and its Application to the Preservation of Food."

To SPENCER WALPOLE, for his paper on "The Fish Supply of London."

To GEORGE F. DEACON, for his paper on "The Constant Supply and Waste of Water."

To Captain RICHARD F. BURTON, for his paper on "Gold on the Gold Coast."

To R. WARINGTON, for his paper on "Some Practical Aspects of Recent Investigation in Nitrification."

To S. G. THOMAS and PERCY C. GILCHRIST, for their paper on the "Manufacture of Steel from Phosphoric Pig-iron."

To ALEXANDER M. CHANCE, for his paper on "The Recovery of Sulphur from Alkali Waste by Schaffner's Process, a record of recent results."

To JAMES MYLNE, for his paper on "Experiences of an European Zemindar (landholder) in Behar."

HOUSE SANITATION COMPETITION.

The Society's Silver Medal :—

To Sir DANIEL COOPER, Bart., K.C.M.G., for the sanitary arrangements of his house, 6, De Vere-gardens, Kensington, W.

To Captain CHARLES ANDREW, for the sanitary arrangements of his house, 286, Kennington-park-road, S.E.

To G. E. MINEARD, for the sanitary arrangements of his house, 106, Philbeach-gardens, Kensington, S.W.

PLANT LABEL COMPETITION.

The Prize of Five Guineas offered through the Society by G. F. Wilson, F.R.S. :—

To E. J. ALMENT, for his Improved Label for Plants.

Sir FREDERICK BRAMWELL, F.R.S., said, it was his privilege, as late Chairman of the Council, to move a hearty vote of thanks to the present Chairman for his address. The Society might be congratulated on this occasion, on having for the Chairman of its Council a gentleman who, of all others, had in recent years applied pure science to the purposes of industry, and had done so with the most marked success. Having regard to what the Society was, and to the objects which it pursued, a gentleman in that position was the one who, if the choice were always open, would be selected for the purpose ; but such persons were scarce, and very difficult to catch ; and he looked upon it as one of the greatest feats of the Council, over which he had had the honour to preside last year, that they had caught his successor and had placed him in that chair. Dr. Siemens, when applied to, put forward the feeble excuse that he was about to become President of the British Association, and he did not see therefore how he could be Chairman of the Society of Arts. The Council replied that this was no excuse at all ; on the contrary, it was the very reason why they wanted him. Then he said, as he had said that evening, that he should be pumped out by having said all he had to say at Southampton, to which he (Sir Frederick) replied that it would take not only Southampton, but a great many towns, to pump Dr. Siemens dry ; and that the Society of Arts would be well content with the practical residuum after he had delivered himself of pure science. He was sure that the meeting would feel that the address that evening justified that answer, and justified the Council for having insisted on Dr. Siemens becoming their Chairman. His address had been confined almost exclusively to one subject—one of many of which he was a thorough master—that of electric lighting. He had touched upon a variety of topics in connection with it, but the address was mainly a practical one, relating to that which so many wanted to know—what was possible to be done, what would be the cost, and what would be the result. Everyone must have been pleased with the information given. Dr. Siemens had himself said that there were other skilled persons who entertained different views—views more favourable as regards area of districts served from one station, and as regards the cost of electric lighting. They all knew that he was not one to set himself up as infallible, and that no one was more ready to acknowledge, if he were proved to be wrong, that someone else was in the right, and that things were better than he had thought. But even supposing Dr. Siemens were right, and that it was not possible to deal with larger areas than he had suggested, or at less cost, yet he had shown that, by an outlay of capital which appeared about two to one as compared to an equal amount of illumination by means of gas, after allowing five per cent. on this double capital, and depreciation on a large portion of it—which on the copper conductors and matters of that kind would be very small indeed—there could be delivered to the consumer the incandescent light, at a price of 22s. as compared with gas at 29s. All who had studied the matter would say that it would not have been an unfair comparison if Dr. Siemens had taken as his standard not gas-light, but the light of luxury which they used in their own houses. Many of them would not have gas-light in their sitting-rooms, and resorted to wax candles or lamps, or something of the kind, the cost of which was considerably in excess of what he had mentioned. He was quite certain, therefore, that there would be a large and increasing demand, on the part of persons living in well-appointed private houses, for a light free from the various objections which appertained to lighting by gas, good as that undoubtedly was, compared with anything which preceded it. However, he would not go further into details which led him away from the true subject before the meeting, which was simply to pass a vote of thanks to Dr. Siemens. He was sure all must feel it was a happy thing for the Society that on this, its 128th anniversary, they had a Chairman in every way competent to guide the Council in the development of the objects of the Society, viz., the promotion of arts, manufactures, and commerce in this country.

LORD ALFRED CHURCHILL begged leave to second most heartily the vote of thanks which had been so ably moved, and to add his testimony to what Sir Frederick Bramwell had said, as to their very fortunate position in being able to secure the services of Dr. Siemens for the current year. The admirable address he had given them, dealt principally with electric lighting ; but he did not think there was anything in it which need cause those interested in gas companies any trepidation. Gas was so essential for heating and cooking purposes, that there was no fear of its falling into disuse.

The motion having been carried unanimously,

Dr. SIEMENS thanked the meeting very heartily for the kind manner in which the address had been received, and Sir F. Bramwell and Lord A. Churchill for the way in which they had spoken of it. He had endeavoured to trace out generally the conditions under which electricity and gas could be most advan-

tageously distributed for practical purposes at the present time, and although he quite agreed with Sir F. Bramwell that conditions might arise which would alter to some extent the principles upon which he argued, yet there were principles of a certain class which were exceedingly stubborn, and not easily moved out of the way. You never could get more than 20s. for a pound; and if one saw statements to the effect that for a given expenditure of power more light could be produced than was theoretically represented in luminons energy, one had a right to doubt such statements. He believed the true progress of the new illuminant would be better ensured by frankly bringing to the front the limits and the cost within which certain effects could be produced, and this he had endeavoured to do. The room that evening was lighted from a machine driven by a gas engine, and this would account for any slight variation which might have been noticed in the light. Gas engines, no doubt, would have a great future, but they must be materially improved, especially in regard to uniformity of action, before they could be used for the purpose of electric lighting to the extent one would wish.

Miscellaneous.

PHOSPHATE INDUSTRIES OF AMERICA.

It appears from a special report of the United States Department of Agriculture, recently issued, that the phosphate beds of South Carolina contain an almost inexhaustible mine of wealth. They are spread over a wide range of territory, extending from North Carolina to Florida, and in some places as much as sixty miles inland. In the regions where the phosphates are found, the face of the country is very flat, the level of the land generally not being more than ten feet above high water mark. The coast line of South Carolina is formed by islands and peninsulas separated from each other and the main land by broad arms of the sea. The main land is intersected by large rivers, which are filled with salt or brackish water, the tide rising and falling in them for many miles from their mouths. In the channels of these rivers, and underlying the adjacent lands, the phosphate deposits are found; they are of remote geological formation, but were not discovered until after the war or secession. This development has been very rapid, and the capital at present invested on mining and preparing the crude rock for market amounts to millions of dollars. The phosphates are found at the bottom of rivers twenty to thirty feet in depth, and on land at an elevation slightly above mean high tide. The most prominent characteristic of the Carolina phosphate is its nodular form, the nodules being of egg or kidney shape, and varying in size from the fraction of an inch, to several feet in diameter; and in weight from a ton downwards. The nodular strata vary in thickness, the average depth being about eight inches. The nodules are rough and indented, often honeycombed by round or irregular holes and cavities, or they are smooth and compact. They vary in colour from olive or bluish-black to a yellowish or greyish white, the land rock being generally lighter than that found under water or mud. The land rock is found at a depth of from two to ten feet below the general surface of the soil, in a loose layer varying from a few inches to thirty inches in depth, the average thickness of the layers being about eight inches. It occurs in sand, mud, clay, or peat, and is often intermingled with numerous remains of land and marine animals, such as the mastodon, elephant, tapir, deer, and also of domestic animals. These remains are found intermingled with, but never imbedded in, the phosphate rocks. The remains of marine animals are very abundant in the rocks, and well preserved specimens of sharks' teeth, from two to four inches in length, have been found in what are called the "Santee marls." Specimens of these teeth have also been found in artesian wells, in the phosphate region, at a depth of 700 feet from the surface of the ground. In analyses made by Dr. Shephard, chemist to the State Department of Agriculture, the following per-centages of the important constituents of the phosphate rock are given:—Phosphoric acid 25 to 28 per cent., the equivalent of 55 to 61 per cent. of bone phosphate of lime; carbonic acid $2\frac{1}{2}$ to 5 per cent.; carbonate of lime 5 to 11 per cent.; sulphuric acid $\frac{1}{2}$ to 2 per cent.; lime 35 to 42 per cent.; sand and silica 4 to 12 per cent.; organic matter and water 2 to 10 per cent.; with traces of fluorine, iron, magnesia, alumina, and other elements. The organic matter is nitrogenous, containing occasionally as high as a quarter per cent. of nitrogen. The extent of the deposits has not yet been definitely ascertained, and widely varying estimates as to the quantity of rock, from 5,000,000 to 500,000,000 tons, have been made. Dr. Shephard traced the deposit over 240,000 acres, and estimated that the accessible rock covered 10,000 acres. The yield per acre of clean and dry rock varies from 300 to 1,200 tons, and it stands in a certain ratio to the thickness of the stratum. The mining and preparation of the rock for market, requires the investment of large capital, and the expenditure of heavy labour. Parallel ditches, two yards wide, are sunk through the soft soil, to a depth of four to seven feet, to the stratum of sand or mud, in which the loose layer of phosphate nodules is found. The rock is shovelled out, thrown into heaps, and carried by rail to the washing places, situated on the wharves, whence it is shipped. The land deposits are excavated with pick and shovel, and an ordinary labourer will raise a ton per day, for which he is paid about seven shillings. The rock is cleaned by first washing it in an inclined perforated iron cylinder; it is then placed in long "washers" made of wood or iron, in which is a shaft, armed with projecting steel teeth,

set at such an angle with the shaft as to form a spiral screw. This moves the nodules up the inclined bed of the "washers," against a heavy stream of water, which enters at the upper end of the washer, and empties itself through an overflow at that end. The friction of one piece of rock with another, as they pass through the washer, effectually cleanses it of all foreign matter. The rock is sometimes cleansed in a cylindrical washer, the cylinder being furnished with spiral flanges of iron, which keep the rock rolling and ascending an inclined tube, a powerful stream of water being distributed through the rock by means of a perforated pipe running through the cylinder. From the upper end of the washer the clean rock falls out upon an iron grating. The capacity of a washing machine is fifty tons per diem. The phosphate deposits in the river beds, or forming the floor of the shallow arms of the sea along the coast, are mined with crowbar and pick, tongs and dredges, according to their depth below the surface of the water. A large part of the Carolina phosphate is raised from the bottom of the rivers by steam dredging boats, which are operated successfully in about twelve feet of water, and frequently in twice that depth. These dredges are very powerful, and can raise about 100 tons of rock a day. The "dipper," of the dredging machine, empties its load of rock, marl, mud, and sand, on a grating, or into a conical "washer," where it is subjected to a heavy stream of water, which carries off the greater part of the mud and sand, thereby enabling the workmen to detect any pieces of marl, sandstone, or oyster shells that may be mixed with the rock. The partially cleaned rock then falls into a crusher, and thence into a second washer, where the fragments are thoroughly cleansed from remaining impurities. The washing apparatus employed in the preparation of the river rock is either upright or caldron shaped, or similar to the "shaft washers" already described. They discharge the washed rock upon lighters, for transportation to the drying shed, where it is heaped upon and around perforated iron pipes, which conduct hot air, driven from an oven by a fan, through every part; a few days continuous drying is sufficient to expel all the moisture. The price of Carolina phosphate has of late years averaged about twenty-five shillings a ton, and it is estimated that the capital invested in in manufacturing and mining, is from a million and a-half to two millions sterling, and from 5,000 to 6,000 persons are engaged in the business.

CULTIVATION OF RICE IN JAPAN.

Rice is the chief product of the soil of Japan, as it is the chief article of food of the people. In the early days, the government treasury consisted of granaries of rice, and in the absence of a monetary system, rice was the standard of value. All taxes were paid in this grain, and, military and civil officers received hereditary incomes from the Government in rice. Its cultivation was therefore of the first importance. Consul Jones informs us, in his last report, that as water was of prime necessity in its cultivation (rice being sown, transplanted, and grown under water), the building of canals and water sluices was encouraged in order that irrigation might be carried on to its fullest extent. In very many places, on low lands, at the base of mountains, vast reservoirs have been constructed. Lakes above the sea level have been tapped, and the water carried through paved conduits to the plains below. The rice lands in the plains and valleys are divided into small plots and gardens, and are entirely without fences, being bounded only by water courses, fences being unnecessary from the absence of any ranging live stock. Preparations for sowing rice begin in March. The ground is broken mostly by hand, or with a plough drawn by a single bullock. This plough is composed of wood: one angle extends upwards for the farmer to guide with, the other holds the traces of the bullock, the animal being guided by a line through his nostril. There is a piece of iron shaped like a heart fastened to the point of this plough, which makes a furrow about five inches deep and six inches wide. Hand labourers, by whom the greater part of the work is done, dig the ground with a wooden-handled implement, shaped like the letter A, with the iron blade almost as long as the handle, and about three inches wide. When the ground is broken, the water is turned on at a depth of two or three inches; a few days later the ground is harrowed and levelled, all lumps of earth being carefully broken, and it is then ready for planting. A month or six weeks previous to this, however, a small patch of ground is broken up by the farmer and flooded, when the seed rice, which has been soaked in water for a short time, is thickly sown upon it. In a month or six weeks this has taken good root and stock, and is ready for transplanting. The farmer then takes the growing rice, divides it carefully into small bunches, tied with a piece of rice straw, and transplants it in the ground prepared for it, a few spears together, in rows a few inches apart. The plots are constantly supplied with water for about two months, when they are drained and allowed to dry. Early in October, the rice is ripe and ready to be gathered, which is done by hand. In gathering the rice, an instrument is used, something like the old-fashioned reaping hook, to cut the straw. It is then tied up in bundles and carried to the barn, either on sticks slung over men's shoulders, or on pack saddles by bullocks and horses. The rice is separated from the straw by women and children striking it against wooden teeth set in a row, of sufficient width apart to permit the straw to pass, but not the rice heads. After separation, the straw is used for various purposes, such as making bags to hold the cleansed rice, thatching roofs, &c.; it is also used as food for cattle and horses, by cutting it up and mixing it with bran. To clean the rice, it is beaten with sticks and sifted, and then run through a mill to take off the husks. This mill

is constructed of two bamboo baskets without bottoms, resting one on the other; these are filled with bamboo splints about a foot long, and burnt at one end, which are placed perpendicularly in the baskets and cemented solidly together by mortar. The bamboo ends act as the cuttings on a flour mill stone; the basket, bamboo splints, and cement as the mill-stones themselves. The upper basket is turned round by a handle fastened at one side, which is arranged as a kind of crank and worked by hand. After the rice has been cleaned in this manner, it is packed in straw bags of about 120 pounds each, and is then ready for the market. Before it can be used as food, it is pounded by hand in a mortar, to thoroughly clean it from the husks. Consul Jones states that the best rice in Japan is grown in the province of Higo, in the neighbourhood of Nagasaki, and the average price on the Nagasaki market is from ten to twelve shillings per picul of 133 pounds. The average annual value of the rice crop of Japan is estimated at about £16,150,000, and the annual export at £42,200.

FISHING TRADE OF GREAT GRIMSBY.

Mr. J. M. Lundie sends the following statistics relating to the fishing trade of Grimsby, in which it is computed a capital of close upon a million sterling is invested :—

THE FOLLOWING GIVES THE AMOUNT OF FISH LANDED IN THE PORT FROM THE NORTH SEA :—

Date.	Imports.	Export—Foreign.
1854	Previous to this date there was no fishing of any importance.	
1859	4,950 tons	Nil.
1864	12,299 ,,	
1869	24,139 ,,	
1874	33,434 ,,	of which 1,700 tons were sent per steamers to the Continent.
1879	49,468 ,,	,, 3,520 ,, ,,
1881	50,612 ,,	,, 3,036 ,, ,,
Total amounts for 22 years	170,902 tons	8,255 tons in seven years.

No trustworthy figures are to hand of the value of the fish, but it must be enormous, as out of an estimated population in 1881 of 45,000, some 30,000 persons, directly or indirectly, obtained a livelihood from the fishing industry. The number of fishing vessels belonging to the port is 861, according to the last list issued; but, allowing for those which have been lost from time to time, the actual number now afloat would be about 625 registered at the port of Grimsby. There are over 700 fishing vessels sailing out of the port of Grimsby, but this is accounted for by some of the vessels being registered at other ports. The average tonnage is about sixty tons, giving a gross of 42,000 tons of burthen belonging to the port in the shape of fishing vessels

The Manchester, Sheffield, and London Railway Company afford great facilities for the trade, and there are now twenty-three acres of dock accommodation, besides a wharf over 500 yards long, devoted exclusively to the fishing trade. Rows of rails run along side this wharf or "pontoon," as it is called, so that fish can be dispatched with all speed to the various inland towns. London takes by far the greater part of this fish supply, which is sent by water as well as by rail.

In conclusion, I may say that the whole question of the "North Sea Fisheries" has lately been the subject of a Government inquiry, conducted by the Board of Trade, as to the general management of the trade, and the treatment of the fishing lads employed therein.

TELEPHONE STATISTICS.

The *Compagnie Internationale des Telephones* have collected and published statistics on the utilisation of telephonic communication throughout the world, which are quoted in the *Economist*. It is in the United States that the telephone is most widely used, the companies there having no need to ask for State concessions. Even the villages of little more than 1,000 inhabitants have the telephone system in operation; and altogether, it is calculated that the various American companies have, amongst them, about 100,000 subscribers. In New York the number of subscribers is set down at 4,060, while Chicago is credited with 2,726. Next to the United States stands Great Britain, which is returned as having the telephone in operation in 47 towns, supplying 4,946 subscribers, of whom 1,561 are in London, 692 in Manchester, 681 in Liverpool, and 600 in Glasgow. Only 8 French towns are reported to be supplied with systems of telephonic communication, and out of the 3,640 subscribers with which these towns are credited, 2,422 are in Paris, which relatively to population, therefore, makes much more general use of the new instrument than London. Berlin, with about half the population of Paris, has only 581 subscribers, or a little more than a fifth of the number of the French capital, and throughout Germany there are, according to these statistics, only 2,322 subscribers to telephone systems, and ten towns in which systems have been established. Belgium is credited with 2,156 subscribers, or very nearly as many as Germany. In Austro-Hungary, only Vienna, Pesth, and Trieste are returned as possessing means of telephonic communication, the number of subscribers in Vienna being 600, in Pesth, 300, and in Trieste 30. Very much better supplied is Italy, which has the system in operation in twelve towns, the aggregate number of subscribers being 2,902. And yet only three Russian towns—St. Petersburg, Moscow, and Odessa—are

reported to be furnished with the telephone; but concessions, it is stated, have been obtained for several others. Switzerland has the system in operation at Bâle, Berne, and Zurich. In Holland. Amsterdam and Rotterdam only are given as enjoying a service. In Denmark, the system is stated not to have extended beyond Copenhagen; and as regards Sweden, we have details respecting Stockholm alone, although it is stated that in most of the important towns the system is being established. Outside of Europe and the United States, the only countries returned as possessing this means of communication are India, which has it in operation at Calcutta, Bombay, and Madras; Egypt, which has the system in Alexandria and Cairo; and Mexico, in the capital of which a telephonic company is established.

Correspondence.

SPECTROSCOPIC OBSERVATIONS OF THE COMET.

The comet is attracting much attention at the present moment, and many people perhaps, like myself, would be pleased to obtain, besides other information respecting it, the results of spectroscopic analysis of its tail; will any reader who is in possession of this knowledge, kindly lay it before the readers of this *Journal*.

CHARLES SOHN, JUN.

311, Camden-road, London, N.W.
November 14, 1882.

General Notes.

PROPOSED BERLIN EXHIBITION.—At a recent meeting of the Berlin Society for the Promotion of Industrial Activity, Professor Vogel reported as to the deliberations of the technical committee charged with the examination of the question of an international exhibition. He brought forward a proposal that the Imperial government should be requested to arrange that the next international exhibition, after that of Italy, should take place in Berlin. He called attention to the important commercial and industrial development of Berlin during the last ten years, and alluded to the fact that Berlin now competes with Paris in several branches of industry which were formerly supposed to be specially the province of the French capital. The making up of clothing occupies over 50,000 persons in Berlin; the exports of goods of this class to North America alone, having been, in 1880, £140,000, and, in 1881, £190,000. The total annual value of the shawls made in Berlin is estimated at £650,000, of which about £400,000 worth is exported. The United States' consular returns show that the annual exports to that market, of Berlin goods, have increased from £375,000, in 1876, to £800,000 in 1881. The development of the various branches of industry in the German capital has been on a scale of marked importance.

VINE CULTIVATION AT VENICE.—The British Vice-Consul at Venice, reporting on the vintage of 1881, says, it was more productive than in former years, and the wines made were of excellent quality. In Venetia, no attention is paid by proprietors of vineyards to the making of the wine, which is sent to the market in the natural state of grape juice. The vines are planted in such a way that a great part of their strength is lost amid an exuberance of boughs and leaves. They are generally cultivated between maize and nut trees, and frequently the sun has not free access to the fruit. Vines of different qualities are planted together, and thus when the clusters on some of them are turning purple, those on the neighbouring vines are green. The peasant pays no attention to the different degrees of ripeness, but gathers all the grapes at the same time and throws them together to ferment in the same vat. The general results is a decoction, which must be drunk up before the next vintage. There is not the least doubt that if Venetian wine growers would improve their wines for exportation, their vintages would be specially introduced on foreign markets.

MEETINGS FOR THE ENSUING WEEK.

TUESDAY, Nov. 21...Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on Major Allen Cunningham's paper, "Recent Hydraulic Experiments." 2. "American Practice in Heating Buildings by Steam," by the late Robert Briggs.

Royal Colonial, the Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Sir Francis Dillon Bell, "The Indebtedness of the Australian Colonies in Relation to their Resources."

WEDNESDAY, Nov. 22...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. John Hopkinson, "Ice Making and Refrigeration."

THURSDAY, Nov. 23...Telegraph Engineers and Electricians, 25, Great George-street, Westminster, S.W., 8 p.m. Lieut.-Colonel C. E. Webber, "Notes on the Telegraphs used during the Operations of the Expeditionary Force in Egypt."

FRIDAY, Nov. 24...Quekett Microscopical Club, University College, W.C., 8 p.m. Mr. B. W. Priest, "Fresh-water Sponges."

SATURDAY, Nov. 25...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Dr F. Guthrie, "Liquid Slabs." 2. Mr. W. Ackroyd, "Rainbows Formed by Reflected Light."

Journal of the Society of Arts.

No. 1,566. Vol. XXX.

FRIDAY, NOVEMBER 24, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

SECOND ORDINARY MEETING.

Wednesday, November 22, 1882; Charles William Siemens, D.C.L., LL.D., Chairman of Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Burbridge, Samuel, 9, Blomfield-street, E.C., and Woodlands, Hither-green, S.E.
Chapman, John T., 2, Arlington-square, N.
Church, Very Rev. Richard William, M.A., Dean of St. Paul's, Deanery, St. Paul's, E.C.
Clark, Thomas Sutton, 38, Faulkner-street, Manchester.
Dysart, Earl of, 29, Chesham-place, S.W.
Ford, William Wilbraham, 9, Spring-gardens, S.W.
Geake, John B., 42, King-st., Covent-garden, W.C.
Johnson, Richard, Great Northern Railway, King's-cross, N.
Kent, Henry, The Grange, 52, Shepherd's-bush-green, W.
Sandeman, Lieut.-Colonel John Glas, Whin Hurst, Hayling Island, and 24, Cambridge-square, W.
Shand, Edgar, Adelaide-buildings, London-bridge, E.C.
Skrivanow, Gregoire, 32, Rue Vignon, Paris.
Sugg, William Thomas, Vincent-street Works, Westminster, S.W.
Wright, G. Strother, 147, Hartington-road, S.W., and 60, Queen Victoria-street, E.C.

The paper read was—

ICE-MAKING AND REFRIGERATING.

By J. Hopkinson, D.Sc., F.R.S.

The artificial production of cold, in all cases, ultimately involves the conversion of mechanical work into heat. In the steam-engine, gas-engine, or hot-air engine, we have the passage of heat from a hot body to a cold body, part of the heat being converted into mechanical work, and disappearing in the transfer. Refrigerating machines are heat-engines, working backwards; they convert mechanical work into heat, and, in so doing, withdraw heat from a cool body, rendering it colder, and deliver this heat, together with the work converted into heat, to a warm body, rendering it warmer. The general theory of refrigerating machinery stands thus on the same basis as the theory of the steam-engine and hot-air engine.

Broadly, refrigerating machines may be divided into two classes: those which depend on the suitable compression and expansion of air, and those which depend on the condensation and evaporation of a liquid. These two classes correspond precisely with hot-air engines and steam-engines respectively, amongst the instruments which convert heat into mechanical work. Each has its peculiar difficulties to contend with, and its own adaptation to particular purposes. The air-machines have been recently ably dealt with by Mr. Coleman, at the Institution of Civil Engineers. The latter class presents a greater variety, owing to the more extended choice of substances which may be used. Carré has used ammonia, water, and ether; Reece and Linde used ammonia; Harrison, assisted by Siebe and Gorman, have used ether; Tellier, methyl ether; Pictet, sulphurous acid.

The evaporation and recondensation of a liquid may be utilised in two ways for the production of cold. Typical of the first method, is the well-known laboratory ammonia apparatus of Carré. This consists of two vessels, which we will call A and B, capable of resisting a considerable pressure connected by a pipe. The first step in the process consists in preparing liquid ammonia. Vessel A contains a solution of ammonia in water, and is artificially heated; vessel B is kept cool, and the air effectually excluded, if there be any leakage, by a water jacket, and in it the ammonia condenses under the pressure caused by the heat of A. When sufficient ammonia is condensed, A is transferred to a vessel of cold water; the ammonia vapour is rapidly absorbed by the cold water within the vessel A. Under the reduced pressure in B the ammonia boils, absorbing much heat and producing considerable cold. The other method is the precise converse of the condensing steam-engine. In the steam-engine, water is converted to steam in a vessel at a high temperature; it expands in the cylinder of the engine, losing a portion of its heat, which becomes useful mechanical work; it then passes to a second vessel maintained at a lower temperature and pressure, in which it is condensed, giving up the balance of the heat it absorbed

in the boiler. Imagine the water replaced by ether, the temperature of boiler and condenser appropriately lower, and the direction of rotation of the engine reversed by the application of external power, so that, in fact, it becomes a pump. The ether evaporates in the condenser, absorbing heat and causing cold; the ether steam passes to the pump, where it is compressed, converting mechanical power into heat, and, under the pressure exerted, it is condensed and forced at a higher temperature and pressure into the vessel corresponding with the steam boiler, where it gives up its heat as may be arranged. Upon the choice of the liquid used will depend the pressure and temperatures in the two vessels or chambers. At 0° C., the tension of water vapour is 4·6 mm. mercury; of ether, 183·3; of sulphurous anhydride, 1165·1; of ammonia, 3162·9. To produce a litre of water vapour at 0° C., requires 0·0029 units of heat, the unit being the heat required to raise one kilogramme of water 1° C.; to produce a litre of ether vapour at the same temperature requires 0·073 units. At 0° C., each stroke of a pump will abstract by ether vapour nearly thirty times as much heat as by water vapour.

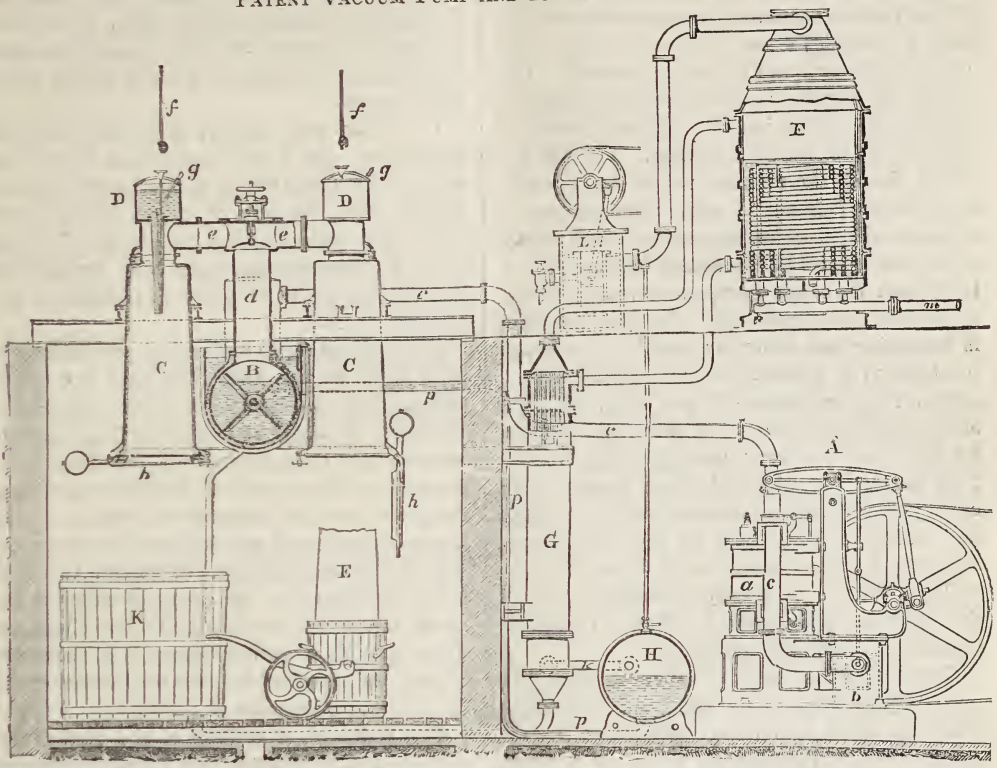
A glance at these figures shows an obvious advantage in using liquids having low boiling points; a pump of small capacity will remove a large quantity of heat, but all such substances are too costly to be wasted, and are offensive if any of the vapour escapes. Water presents obvious advantages, in the fact that we need not care what becomes of the vapour when condensed. But the use of water demands the power to produce and maintain a near approach to a perfect vacuum; the barometric pressure must be reduced from the normal of about 760 mm. of mercury, to less than 4, and for every unit of heat removed, at least 350 litres of vapour must be withdrawn and condensed. Water may be used on either of the methods already mentioned. It may be used in a manner exactly corresponding with Carré's ammonia apparatus, the water taking the place of the ammonia, and some hygroscopic substance, such as sulphuric acid, taking the place of the water, the pressures of course being always very much lower. Or if we can find a sufficiently perfect pump to produce and maintain a vacuum of less than 4 mm. of mercury, we may realise the precise reversal of the condensing steam-engine; but to produce any quantity of ice, the pump must not only be very perfect, but have a great capacity. A combination of the two methods answers best. At the Paris Exhibition of 1878, Carré exhibited refrigerators of this type for freezing the water in carafes or water bottles; it was worked by a hand-pump, and no provision was made for expelling the water absorbed by the sulphuric acid.

Since then, Windhausen and others, who have taken up the practical improvement of his inventions, have brought to a commercial success the manufacture of ice by the evaporation of water at a very low pressure. The diagram (page 21) shows their machinery as now working in Berlin and at the Aylesbury Dairy Company's premises in St. Petersburg-place, Bayswater.

The evaporation of part of the water and freezing of the remainder is effected in six vessels of truncated conical form, C, into which the water is allowed to flow at a regulated speed from six vessels, D, above the cones. The nozzles by which the water flows into the vessels C, are jacketed with the fresh water flowing into the vessel D, for the purpose of preventing them from being choked by the ice which would otherwise form there. The vessels C are closed by hinged lids, *h*, which are made perfectly air-tight by means of two india-rubber rings, with an annular space between them filled with water. To secure the easy disengagement of the mass of ice when completed, the vessels C are jacketed with a space into which steam can be admitted. The vacuum is produced and maintained by a compound air-pump, A. This pump is certainly a remarkable machine; it can produce a vacuum of $\frac{1}{2}$ mm. of mercury—that is, $\frac{1}{1500}$ part of an atmosphere. The large cylinder is double-acting, and has a diameter of 80 cm., and stroke of 50 cm., hence a capacity each revolution of 500 litres. The exit valves are self-acting; the entrance valves are actuated mechanically. The small cylinder is single-acting, and has a diameter of 22 cm. and stroke of 21 cm.; hence a capacity of 8 litres. The normal speed of the pump is 54 revolutions per minute. In beginning to exhaust with this compound pump, very great force would be required, owing to the great size of the large cylinder in comparison with the small. This inconvenience is avoided by opening a release valve giving communication between the two ends of the large cylinder. When a tolerable exhaustion is attained, this valve is closed, and the pump is worked compound, the large cylinder effecting compression of the residual air or vapour to a certain point, and the small cylinder completing the compression to the tension of the external air. But a small part of the water evaporated passes

through the pump; the major portion is absorbed in the cylindrical vessel of boiler-plate, B. In this revolves about a horizontal axis an agitator. This vessel is 7·08 metres long and 85 cms. diameter, and should be about three-quarters full, then holding 3,000 litres of acid. This vessel is surrounded by water, to prevent the temperature of the acid from rising too much, but for this purpose no very large supply of cold water is needed. After three turns have been worked, the acid is so far diluted that it is well to change it for that which has been concentrated. The air having been admitted to B, the dilute acid is

PATENT VACUUM PUMP AND ICE MACHINE.*



A.—Vacuum Pump. *a*, large cylinder; *b*, small cylinder; *c*, suction-pipe from pump to absorber and freezing cylinders.

B.—The Absorber, containing sulphuric acid, which is kept in motion by revolving arms, a vacuum being maintained. *d* and *e*, pipes connecting absorber with ice cylinders, the connection between *d* and *e* being controlled by valve at top of *d*.

C.—The Cylinders in which the ice is formed.

D.—Vessels into which the water to be frozen first passes from the pipe, *f*, before flowing into the cylinders, through the valve controlled by the lever, *g*; *h*, the lid or bottom of the ice cylinder, which is open so as to allow the ice to fall out.

E.—Block of ice.

F.—The Concentrator, in which the acid is freed from the vapours absorbed during the passage of the water from *D* to *C*.

G, H.—Exchange apparatus through which the dilute acid ascends to be concentrated and the concentrated acid descends to the store tank, *H*, from which it can be drawn by the vacuum into the absorber as required. In the exchange apparatus the boiling concentrated acid is cooled during its descent by passing over and outside the pipes through which the cold dilute acid is ascending.

K.—Tank into which the acid is received from the absorber after it has become diluted, and from which it is drawn into the concentrator.

L.—Small vacuum pump for maintaining vacuum in the concentrator. *k*, pipe conveying concentrated acid to store tank, *H*.

m.—Steam-pipe from boiler.

p.—Connecting pipe between absorber and store tank, *H*.

allowed to run out into the tank, K. On again exhausting B, fresh acid is drawn up from the chamber H. The concentration of the acid is effected in a lead-lined vessel, F, in which is a coil of lead-piping heated by the admission of steam from the boiler. The pressure in the vessel F is kept low by means of an ordinary air-pump, L. No acid pump is needed, as all the moving of acid is effected by the pressure of the air. A complete cycle of work would be approximately as follows:—We start, let us say, at twelve o'clock, with acid in the reservoir, having a density of 60° on Baumé's scale, that is an actual density 1·70, equivalent to 79

* This block has been kindly lent by Messrs. Smith, Elder, and Co.

per cent. $H_2 SO_4$ to 21 per cent. water; about forty minutes pumping is required to produce the vacuum before beginning to run in the water; the water is then admitted in a regulated stream to the cylinders, the pump is kept at work, and the vacuum maintained at about 3 mm. of mercury; about 2,160 litres having entered the six cylinders, the flow is stopped; 360 kilogrammes has evaporated, and either of this, 1,800 kilogrammes is formed into ice, and passed through the pump or to the acid. The valves between E and D are now closed. The lids of the vessels C are opened, and steam is introduced into the jacket. The six blocks, of 6 cwt. each, presently fall down. The lids are again closed, the exhaust valves are opened, and the air is pumped out. The process is repeated with a somewhat slower flow of water, as the absorption by the acid is less rapid. A third time is the air pumped out, and 36 cwt. of ice presently produced. But now the acid is becoming too dilute, its density is reduced to about 51·5° Baumé, that is actually a density of 1·55, indicating 66 per cent. $H_2 SO_4$ and 34 per cent. water. It must be changed for that which has been undergoing concentration during the cycle of three turns. The cycle just described, produces 108 cwt. of ice, and occupies from start to the next start, allowing time to change acid, between eight and nine hours. We may, therefore, say that this machine will produce between 15 and 16 tons of ice in twenty-four hours.

Some objection may be taken to the opalescent appearance of the ice, but I venture to think, as there is nothing ugly about it, this appearance will ultimately serve as a trade mark, and will show to the buyer that the ice has, on the one hand, not been collected from some dirty pool, nor on the other, can it be supposed to have absorbed any of the ammonia or ether sometimes used for the manufacture of ice.

The consumption of coals is very small, all told less than 8 per cent. of the weight of ice produced; the acid serves over and over again, indefinitively; the wear and tear of the machine so far appears to be, practically, *nil*, which surprised me much, until I had watched it at work, and taken out some parts which had been many months at work, for examination.

The success of the machine, as regards durability, is largely due to the fact that the sulphuric acid is never so concentrated as to attack lead, and is never so dilute as to attack brass or iron. I carefully tested the condensed water, both from the vacuum pump, and from the concentrator pump, and could detect not the slightest trace of acid. In the early days of the machine, the concentrator consisted of a rectangular cast-iron vessel, without any lead lining; it is astonishing how well the cast iron has withstood the corrosive action of the hot sulphuric acid when ordinary air was absent. One would expect that there would be some difficulty in keeping the journal of the agitator of the absorber tight, exposed as it is on the interior to acid. This is effected by placing the external portion of the shaft under water.

It is not well, rashly, to predict costs of production, but I will venture so far in this case, as to say, that on a large scale, in continuous work, ice can be made at a less cost than 4s. a ton, allowing 10 per cent. on the plant for depreciation, 5 per cent. for interest, and appropriately for other dead charges and contingencies.

It is interesting to notice the proportions of work done by the absorbing acid and by the pump. In a complete cycle, producing 108 cwt., or say, 5,400 kilos of ice, the acid absorbs over 1,000 kilos out of less than 1,100 evaporated; the pump will have passed, during the time that ice has actually been making, between eight and nine million litres of water vapour; assuming a litre of vapour to weigh 0·0035 grammes at the pressure existing, the pump can only have drawn 28 kilos of vapour. Thus, though a perfect pump is a necessary adjunct of the machine, the work is nearly all done by the absorption of the acid.

The indicator diagrams of the engine employed for driving the pumps gave the following results at the various stages:—With no load, 2·15; during the earlier stage of the exhaustion, with the release valve open, 10·1; after closing the release valve, during the process of freezing, 5·0 in maintaining the vacuum. As the power varies at different stages from two to ten horse, it is clear that by judicious arrangement, two complete apparatus could be driven by an engine capable of indicating twelve-horse power. A larger quantity of steam is required for heating the absorber from its coil—about 150 litres of water are condensed per hour. From this figure, and from the indicated horse power, it is easy to see that the consumption of coal may be made very materially less than the 8 per cent. which I have stated as the superior limit.

Practical improvements devised for a particular end are generally found to have applications far beyond the first intention: it is

so here. The apparatus shown in the diagram is designed to manufacture ice or to cool water, and will be found useful in many manufactures—brewers, paraffin oil refiners, and the makers of many chemicals, will all find that cheap cold will facilitate their operations. But beyond this the method now used for concentrating the sulphuric acid will be found useful to the manufacturer of sulphuric acid itself. The pump and absorber together are not merely a refrigerating machine, they are an apparatus for producing an almost perfect vacuum; this may be applied to any case in which it is desired to evaporate water at a low temperature. It is already very successfully applied to this purpose in sugar boiling, and doubtless soon will be in preparing animal extracts, such as essence of beef. But it is useless for me to speculate on possible applications, I will merely say that you may evaporate water from a solution which never rises above the freezing point, at a cost which is, for many purposes, quite insignificant. If so low a temperature is unnecessary, the cost is of course correspondingly less.

DISCUSSION.

The CHAIRMAN said the paper just read contained an able exposition of a method which appeared to be exceptionally promising for producing ice, or cold generally. Dr. Hopkinson had alluded to two methods of producing ice: one, that of expanding and compressing air, and cooling it when compressed, which was the air ice machine, of which a great deal had been made, and which was capable, no doubt, of producing great results; the other was the method of evaporating liquids of low evaporating point, such as ether or ammonia. The machine which had been described partook of the nature of the latter, for it also absorbed heat by evaporating; but the important difference in this case was, that the liquid evaporated was the same from which the ice was to be produced. The inventor of this machine did not surround the vessel containing water to be converted into ice by ether, which was subjected to evaporation and recondensation, but attacked the water direct. They all knew that if water were put under a nearly perfect vacuum, it would generate vapour, and in so doing, heat would be absorbed; and, if a high degree of vacuum could be obtained, the water must be converted bodily into ice. The difficulty that would strike anyone was, how to maintain under the influence of evaporation from the water in the moulds such a high degree of vacuum; if it had to be done by pumping only, a pump of extraordinary dimensions would be required, and probably the process would fail to be an economical one; but here a very ingenious method had been adopted, that of passing the vapour, after it came from the water, through a vessel containing nearly concentrated sulphuric acid. That acid absorbed vapour very readily, and would heat itself in the absorption; in fact, all the heat taken from the water would reappear in the sulphuric acid vessel, and so long as the acid was capable of absorbing this vapour, very little of it would reach the pump. But, as had been explained, the pump must be of such a character as to maintain this high state of vacuum, although its capacity might be considerably reduced, on account of the sulphuric acid taking the bulk of the vapour away. This seemed to have been very beautifully realised by the differential pump, and he could himself speak as to the efficacy of such a pump, having many years ago given some attention to one of that nature, for a totally different object.

Mr. LIGHTFOOT said he had seen this machine at work, and it seemed to do all that the author claimed for it. The only objection which occurred to him was the opalescent appearance of the ice, and that was a matter more for the public than for engineers. From what we know, makers of ice machines had been directing their attention for many years to the production of clear ice, and it was rather astonishing to find a machine brought out producing ice of so totally different a character to anything which had been seen before. With regard to the economical aspect of the question, he had every reason to believe that the production could be carried out at the cost mentioned by Dr. Hopkinson.

Mr. MARTIN WOOD said he should like to ask a question with regard to the economy of this process under adverse conditions. It was obvious that the production of ice was far more important in torrid climates than in England, and especially to European residents in such climates; besides which, there were many manufactures and processes which could be carried on if this artificial cold were produced economically, and without elaborate machinery. The successful commercial application of machinery to the making of ice by the ether process, in India, had been brought under his notice. The General Ice Company, which had been remarkably successful in India, had, he believed, well considered the different processes known, including Pictet's, but they decided on adopting Sidelet's, in which ether was used. It seemed to him that the great difficulty consisted in obtaining the necessary motive power. In many places in India, the difficulty of getting cheap coal would be almost insurmountable, except on a large scale: it could only be obtained in large centres. Still, depôts had been established at Lahore, Allahabad, and other places. In Northern India, ice was obtained by manual labour in the cold weather. This process seemed to be the same as was described a short time ago at the Society of Engineers. Dr. Hopkinson had given the cost, if carried on on a sufficiently large scale, at 4s. a ton; but in the process just referred to 5s. a ton was mentioned for a production of five or six cwt. a day, and

for large quantities 3s. 4d. This process, if it could be carried on in torrid climates, would be an immense boon, and one great practical advantage seemed to be the comparatively small motive-power required.

Mr. JOHN G. MAIR asked whether this ice would last longer, or melt sooner than the ordinary clear ice.

Mr. ERNEST HART remarked that anything he might say about this machine might possibly be somewhat coloured by the fact that he was interested in it; but he had had many opportunities, for some time, of observing its working critically, and with the desire to find out any defects, and so far as he had been able to compare its working with the statements made as to its working in Berlin, and the accurate investigations made by Dr. Hopkinson, it appeared to him that he had by no means exaggerated the actual advantages in working, whilst he had only glanced at the very extensive applications which the ice machine, the vacuum pump, and the sulphuric acid concentrators would each and all have in the arts and manufactures. The actual cost of working would, no doubt, vary according to certain conditions not strictly of an engineering character, but which would have to be taken account of in any industrial applications. For instance, there was the variation in cost of coal and of water, if it had to be paid for. So far as he was aware, ice had never been produced so economically or easily, or by any machine so easily tended, having so little complication, capable of such continuous working, and so free from inconveniences in the way of diffusible chemicals as this. He did not know whether Dr. Hopkinson had any accurate data with regard to the durability of the ice; but those who had been working it in Berlin stated that they had two kinds of experience, one accurate experiment, as the result of which they alleged that the durability of this ice was decidedly greater than that of ordinary clear ice; and they had also a certain industrial experience, the machine there being mainly an experimental one, and sometimes being used for other purposes, they then supplied ordinary ice, which had been refused by some of their customers as not being so durable. Those who were interested in the machine here were having data accurately made out, Professor Guthrie, of the Science Schools at South Kensington, having kindly undertaken to make a series of experiments on the subject. As to the question of its utility in hot climates, it was obvious that a machine on this principle, actuated by so small an amount of coal, which had no diffusible chemical which required recondensation, would be worked at a comparatively much more economical rate in a hot climate, compared to a temperate climate, than a machine which employed diffusible chemicals. As to the other applications of the machine, he must remark that for many of the purposes for which vacuum machines were used, as, for instance, extracts of meat, there was a particular advantage here, because it constantly happened that the vacuum pump was applicable in various stages of the manufacture, which made an absolute vacuum of $\frac{1}{2}$ millimetres on a large scale. It might be used for making ice in the first place, and then, by changing the connections, it might be employed for evaporating sugar, meat juice, or any other of the animal or vegetable juices it was desirable to evaporate at a low temperature. Its application to a great many other processes in England was under consideration, and, no doubt, the ingenuity of manufacturers would be brought to bear in the utilisation of this admirable form of vacuum pump. Professor Abel thought it might be applied with advantage in the manufacture of explosives. They were also told that it might be applied with great advantage in the purification of glycerine in paraffin, soap, oil, chocolate, dye and sugar works. He rather regretted that this side of the question had not been more developed in the paper. For cooling water, it had been estimated that eight times as much water could be cooled as the quantity converted into ice, and when the water did not require to be cooled to a very low temperature, as for breweries and many other purposes, the machine might be greatly simplified; in fact, it was possible to do without the sulphuric acid altogether where the temperature was not required to go below 40 degrees. It was also, to a certain extent, an advantage that the parts might be separately mounted, where there was an objection to introduce the sulphuric acid concentrator and cylinders into a building. He had not pointed out any faults in the machine, because a somewhat extended experience had not yet detected any.

Mr. COTT read the following communication from Mr. J. J. Coleman, who was unable to be present:—In comparing the value of refrigerating machinery, the most scientifically correct way of conducting mechanical refrigeration is not necessarily the best way in practice, any more than with the reverse problem of heating or warming. This will be understood when we consider for a moment that to warm a room with the least expenditure of fuel; nothing could be better than burning the fuel in a stove in the centre of the room, but we know in practice there are various serious objections to this, which prevents it being carried out. Similarly, a practical man intending to use a refrigerator will ask—1. How much space will this machinery take up on board ship, which he values at 2s. to 3s. per cubic foot per voyage? 2. If anything happens to this machinery, can I get it repaired at a foreign port of call, or how am I to get the chemicals for use if put to work in some of the outside stations of our Colonies? Now, if chemical machines are compared with cold-air machines, these questions, and such like, are not satisfactorily answered, because as a rule the chemical apparatus is much more cumbersome, and the parts more numerous than with cold-air machines, which, in construction, are simply plain engine work, and just as conveniently managed as an ordinary

steam-engine; thus in recent cases I have designed such machines after the type of a locomotive, to run upon rails, or as a portable road engine. There are few parts of the world where, in case of a breakdown, cold-air machines cannot be repaired, and engineers obtained for the work; but there are many places where refrigeration is required, which have no such conveniences as would be necessary either for fitting up or keeping in repair of chemical machines. These considerations came prominently before me some three years ago, when considering the kind of apparatus for use in the American meat trade. The vacuum machinery of Windhauson, similar to that recently erected on the premises of the Aylesbury Dairy Company, as well as the sulphurous anhydride machines of Pictet, and the ammonia compression machines of Lindé, were then all of them in operation, and the results of their working familiar to me. In reference to the cost of manufacturing ice by this machine, it is no new thing for refrigerator makers to announce that their apparatus will produce ice at 5s. per ton; this has been repeatedly asserted by makers of the ammonia absorption machines, and the sulphurous anhydride machines of Pictet. In the trade circulars issued by the makers of these machines, such calculations have been made for the last ten years; still, as a matter of fact, we find that such machinery has, in practice, worked very irregularly, and with frequent breakdowns, and in no case have these machines been able to manufacture ice for the market at the price stated. No doubt the ammonia compression process, and Windhauson's vacuum process, can be worked on a large scale, where first-class engineering shops, oil of vitriol, &c., are near at hand; but the process, particularly Windhauson's, means really chemical works, requiring no ordinary skill to manage, and on that account the demand for that class of machinery will always be limited.

Mr. FILDES said he presumed the opalescent appearance of the ice was due to the presence of air particles in the mass, as was the case with snow, and with glacier ice at the surface, though it was translucent lower down, where it was subjected to pressure. He should like to ask Dr. Hopkinson's opinion, therefore, whether it would be possible to remove this opalescent appearance by subjecting the mass to pressure, so as to remove the air?

Mr. A. S. HASLAM said he had had many years' experience with ammonia machines, and had watched very carefully the results from different sized machines, varying from a capacity of five tons per day up to fourteen or twenty tons. He had noticed that there was a very marked economy in the large machines. In one that would make twenty tons per day, the cost did not exceed 3s. per ton; whilst with a six ton machine it would be increased to 5s., or 5s. 6d. He should like to ask, therefore, if Dr. Hopkinson could give any data whereby they could approximately compare the cost of the two machines. He had heard, with some surprise, the comparisons made between ice-making machines and cold-air machines, which were hardly fair. Each machine had its own use, and no doubt for ice-making one of this kind was the best, whilst for producing cold air, especially on board ship, others might be more suitable.

Mrs. JOLLY said Dr. Hopkinson had not told them anything about Reece's machine, which was very successful, and made ice at 2s. 6d. per ton. If she had known in time, she would have sent some pyramids of perfectly clear ice produced by it; she thought many customers would object to having ice which looked like snow. Again, the ice blocks exhibited seemed to be visibly wasting; but she had had pyramids of ice at the Agricultural-hall which had been presentable for three days, made by Reece's machine in Upper Ground-street. It was quite necessary to have some artificial means of making ice, as the consumption was daily getting greater. She was a manufacturer of refrigerators, and should be glad if every family had one, as they had in America, costing not more than £2, and which they could supply with ice for 3d. a day. What was really wanted, was a small machine which would make, say, 6 lbs. of ice per hour by hand labour.

Mr. AUMONIER asked if the cost just mentioned included any payment for water?

Mr. CLEMENTS said he remembered seeing Pictet's machine at work in the Paris Exhibition of 1878, and the ice it produced had more the appearance of natural ice. It struck him that there must be an enormous profit on the sale of ice if it could be produced at the cost which had been named, about 80 lb. for 2d., considering it was sold for 2d. a pound.

Mr. HUGHES thought the chief cost of this machine, as was the case with most others, would be the motive power, and would suggest that in India windmills might be employed, as was now being done for waterworks and irrigation.

Mr. WILLIAM BOTLY referred to various applications of vacuum processes in the arts and manufactures, especially to Howard's invention of sugar boiling in vacuo. He believed that if the process described were more generally extended, it would be very applicable in many ways. Again, considering to how great an extent we were dependent on foreign countries for our meat supply, it was obviously of the utmost importance that this process should be developed.

Mr. A. W. L. REDDIE said what had been pointed out by Mr. Haslam was quite correct—that there was no comparison to be made between a cold-air machine and this, which was essentially a cold-water machine. The remarks of the last speaker confirmed that view, for he seemed to imagine that the making of ice was of great importance to the transport of meat across the ocean. A consideration of the facts would show that the cold-air machines were

about as well suited for that purpose as could be, far more so than a system which would involve breaking up ice and packing things in it. He should also take exception to the term opalescent, which he always understood involved the idea of colour; he should prefer to call this opaque, as distinguished from clear ice.

Mr. Ernest Hart could not help thinking that if Mr. Coleman had been present, the remarks which had been made on his behalf would not have been presented, since a great deal of them had been anticipated by Dr. Hopkinson. The figures were verified figures, not imaginary ones; and he might add that any such anticipatory observations as to the action of a machine investigated three years ago, when it was in its infancy, could be no test of what it could do now.

Mr. Martin Wood asked if Dr. Hopkinson could give an idea of the cost of the machine itself, and any guess of the cost of a small one, such as could be worked by hand labour, to produce a few pounds of ice per day.

Dr. Hopkinson said this machine had a great advantage in the small amount of motive power required; as far as he knew, it produced ice at a less expenditure of coal than any other. And in many cases an apparatus, which he had not described, was introduced for still further reducing the quantity of fuel. This was an exchange apparatus, somewhat on the principle of Dr. Siemens's regenerative furnace, by which the cool acid coming from the reservoir passed through a series of pipes in a vessel, where it met, passing round it, the hot acid coming from the concentrator, so that the spare heat, which would otherwise be wasted, was utilised in warming the weak acid before it entered the concentrating chamber. This would sensibly diminish the amount of coal required, but it was not in use in the machine from which he had made his calculations. Mr. Wood had pointed out the great resemblance between this machine and the one described by Mr. Peiper at the Society of Engineers, which was not at all surprising, seeing that the machines were identical, and, by arrangement with Mr. Peiper, he had used the same diagrams. The opalescent or semi-opaque appearance of the ice was due to the fact that it was not a continuous mass; it was formed as hail or snow, and as it fell, there were minute spaces between the crystals, though they were not occupied by air when it was made. *A priori*, one would expect that a non-continuous mass like this would be a slower conductor of heat than a solid continuous body like ice, and, therefore, that it would melt more slowly than an equal weight of ice. He had no experimental data to go upon on this point, but they had heard what had been said by Mr. Hart. With regard to the quantity of water which could be cooled, it would depend on the initial and final temperatures; but a calculation could easily be made. To freeze a unit mass of water required something like 80 units of heat for each degree of the Centigrade scale; therefore, to cool water from the 5° C. to 0° C., without freezing, would require 15 units; and to cool it 15°, and then freeze it, would require 95°, and so in any similar case. The representative of the Bell-Coleman Company had pointed out the great importance of having a machine which was easy of repair; he did not think there was any part of this machine which an ordinary mechanic could not reproduce or repair. The efficiency of the machine depended very largely on the perfection of its design. Sulphuric acid could be obtained all the world over. Of course, the machine had not yet run for many years, but it had done so for many months, and, so far, no sign of a breakdown has been detected, and, probably, if there had been a weak point, it would have shown itself before now. With regard to his estimate of cost, he must say that he had acted entirely as an independent critic, it being no part of his business to put the best colour he could upon it. The cost of 3s. per ton, mentioned by Mr. Haslam, somewhat surprised him, and it would be well if some particulars were given as to the rate of depreciation and interest adopted in the estimate. He had mentioned Reece's machine, which was a very interesting one; but if he had attempted to describe in detail all ice-making machines—and he could hardly have described one without going through them all—he should have taken all night. He had not put down anything for the cost of water, but that could not be very important, as there was no need to waste any. A remark had been made as to the discrepancy between the price charged to the public for small quantities, and the cost which the makers of ice machines claimed it could be produced for, but the great cost of distributing small quantities of anything must be borne in mind, especially a perishable article like ice. He was not in a position to give any estimate of the cost of a small hand-machine, but there was a small machine shown in Paris, with no provision for reconcentrating the acid, and no doubt the price could be obtained from M. Carré. That was a cold-water machine, but he did not think it could be applied on a large scale. He might support Mr. Hart's statement that it was hardly fair to compare what this machine of Windhauson's was capable of doing three years ago, to what other machines were doing at that time; since then, it had become a practical instrument for manufacturing ice on a large scale.

The Chairman, in proposing a vote of thanks to Dr. Hopkinson for his paper, said they must all agree that he had, with his usual clearness and exactitude as to facts and experimental data, brought before them a description of a very interesting mode of refrigeration. He agreed with some of the speakers, who pointed out that this machine, however meritorious it might be, need not necessarily supersede other machines, which had proved in practice thoroughly useful. It was generally the case that a

new machine or method largely extended applications, without materially interfering with other processes by which similar effects were produced. It was not their wish to supersede, but to put new methods in competition with old ones, in order to get a larger and cheaper supply of this great commodity of the day—ice—and refrigerators.

The vote of thanks was carried unanimously, and the meeting adjourned.

Miscellaneous.

THE BRAZILIAN EXHIBITION AT BERLIN.

The attempt which is being made by the Central Association for Commercial Geography to familiarise inhabitants of the German empire (and indirectly the other nations of Europe) with the natural and industrial resources of Brazil is, to a certain extent, novel; and the ill-fated exhibition at Porto Alegre was in part designed for the purpose of displaying to the Brazilian people the leading products of German industry. In addition to the direct interest which German shipping houses at the Brazilian ports, and their correspondents at Hamburg or Bremen, would have in the development of trade in the various products usually received from South America, there is the additional prospective gain arising from the introduction, on a more extensive scale, of the work of German looms and furnaces into the Brazilian market.

The scheme was originally supported by the Brazilian Government in a practical manner, and a grant of money was in view. A change of Government proved, however, to be unfavourable to the prospects of the Exhibition. The reluctance of certain leading firms to participate in the display was also a disappointment to the promoters. Thus the collection, submitted to the public of Berlin on October 31st, has not been grouped together without a full proportion of the difficulties usual in such cases.

The show of cotton is considered hardly on a par with the display of the other articles received from Brazil. As, however, the production of cotton is by no means so important as it was ten years ago, this fact is easily accounted for. According to the *Central Blatt für Textil Industrie*, the reduction of the annual yield has been from 90 million pounds in 1873, to only 30 million pounds in 1880. This remarkable decline is attributed to the rapid development of the cultivation of coffee and sugar. The latter articles have proved more profitable than cotton, and there being no increase of population or immigration on a scale commensurate with the augmented importance of these branches of agriculture, the needful labour has had to be diverted from cotton-growing. In the absence of exact internal statistics, the above figures are based, it would seem, on the exports. They may, however, be fairly considered to show the state of the case, as the domestic textile industry is too unimportant to have, by any increased requirements, caused the large falling-off in cotton exports during recent years.

Silk-worm cultivation is represented by samples of raw silk reeled by J. D. Von Schlabiendorf, who has at his establishment, in the province of Rio Grande do Sul, no less than 600,000 mulberry trees of four years' growth. Samples of silk produced in another district by Italian colonists are also exhibited. For the purpose of comparison, a variety of samples of European and Asiatic silks are displayed in an adjacent show-case.

The richness of Brazilian vegetation is illustrated by a varied collection of fibres. The Gravata fibre (yielded by the wild pine-apple) is exhibited by Herr Frehse, who also contributes a specimen of the straw. Regret has been expressed that no samples of yarn from these fibres have been shown, as illustrating the practical uses to which they are put in Brazil; and it is suggested that at the close of the Exhibition the samples should be placed in the hands of suitable manufacturers, in order that the industrial value of the fibres represented might be fairly tested. Amongst other fibre exhibits, notice has been accorded in the technical press to the Macahyba fibre, shown by the *Sociedade auxiliàdora de Agricultura* of Pernambuco.

The national wool manufacturing industry is represented by samples of flannels and cloths from the factory of C. Rheingantz (Rio Grande do Sul). The class of flannel made by this firm is largely used in southern Brazil. This house also supplies cloth which is used in the Brazilian army. It is a subject for comment, that the Brazilian cotton spinning and weaving industries have not contributed anything to the Exhibition. There are, it appears, 860 looms and 85,000 spindles, occupied in that branch of the national manufactures.

The walls are covered with curious ornamentation, somewhat grotesquely contrived from skins of various animals. Tropical plants are found in luxuriant profusion, and the scene is rendered more attractive by numbers of stuffed animals and birds. The specimens of preserved fruits are described as being effectively arranged. Tobacco and cigars of Brazilian origin are also shown, while the display of objects connected with the sugar and liquor industries is very complete. Dye-woods of various descriptions find a place amongst the objects exhibited.

The importance of coffee as an article of export has been fully recognised by the promoters of the display, a special exhibition having been organised in connection with the illustration of various matters connected with that subject. A pyramid of blocks has been erected, with a view of showing the importance of Brazil as a coffee-producing country. The foundation of the pyramid is a block representing the total annual yield of coffee in the whole world; about 600,000 tons. Immediately above this block is a second one, showing the proportion grown in Brazil,

which is nearly 300,000 tons. Above this block rise others, illustrating respectively the yield of the Dutch colonies in the east, Venezuela, Ceylon, and Hayti, &c. No less than 200 samples in an adjacent room show the peculiarities of various descriptions thus indicated. The leather industry is also represented to a certain extent.

ANTHRACITE COAL-FIELDS OF PENNSYLVANIA.

Consul Clipperton, writing on the coal-mining districts of Pennsylvania, says that the anthracite territory is small as compared with the bituminous n that State, while throughout the western States of the American Union, the supply is considered to be almost beyond approximation. The anthracite area in the United States is 470 square miles, while the bituminous coal-fields cover twice the area of the four great American lakes. The relative thickness of the beds is, however, at great variance. If the anthracite beds were spread out as thinly as those of the bituminous region, they would, according to Consul Clipperton, cover eight times their present area, and if the denuded spaces within the borders of the anthracite coal-fields were covered with a deposit of coal as thick as they probably once were, the available area would be increased to about 2,000 square miles, or 1,280,000 acres, equal to a coal deposit of 92,840,960,000 tons. The arrangement of the Pennsylvania anthracite beds are wonderfully complex. They are found without evidence of volcanic disruption, contortions, or disturbance of strata. The beds are rarely horizontal, but lie at every angle, sometimes even passing the perpendicular, and rolling back upon themselves, occupying in places mountain summits nearly 2,000 feet above the level of the sea, and in others falling more than 3,000 feet below it, varying a mile in altitude. The coal, the frailest material in all this mass of rock, is not destroyed, and is found generally in good condition, solid, almost crystalised, almost pure carbon, and frequently in beds too thick for economical working. Faults in the anthracite beds usually have a north-west and south-east direction, showing the beds compressed, and again correspondingly enlarged, but no sudden dislocations or breaking off of the strata. Soft coal, or dirt faults, are of common occurrence in the red ash or softer coal in the western end of the anthracite fields. The anthracite region, mainly confined to one-sixth of the four mountainous regions of Luserne, Schuylkill, Carbon, and Northumberland, is crowded with an industrious population, which increased 51 per cent. in ten years, namely, from 229,700 in 1860, to 344,771 in 1870, while the four adjacent agricultural counties, of similar area, increased in the same period from 319,542 to 339,942, or only six per cent. In mining and preparing anthracite, there is involved a very considerable loss of valuable material. The position of the coal in large solid beds, and its inclined positions, require strong supports to keep the superincumbent mass from crushing and closing the avenues to the mines, and they must consist of massive pillars of the solid coal itself. Wooden props, however strong and ponderous, can only be used for the minor supports. Some of the pillar coal is eventually removed, but much of it is inevitably lost, especially in the larger beds, which frequently range from 20 to 46 feet in thickness, and are often inclined at an angle of from 40 to 70 degrees. It is estimated that not more than 66 per cent. is obtained from the mines. When brought to the surface, the coal is run through a "breaker," which is from 80 to 100 feet high, and ingeniously contrived for the breaking of the product into the required sizes. Of these immense buildings, there are over 300 in the anthracite region, costing on an average £10,000 each. To the top of these the coal is hoisted, and descends through a succession of rolls and screens, emerging at the bottom in a series of assorted sizes, from huge blocks of lump coal to unmarketable dust, the latter forming a large proportion of the whole. This process involves a loss of good coal equal to from 20 to 25 per cent. of the gross amount mined. For the coal wasted—in mining, about 40 per cent., and in preparing, 25 per cent.—no one is paid, it being a total loss to the landowner, miner, and shipper. Many plans have been suggested for utilising the waste coal dirt or culm of anthracite collieries, but, up to the present, none have come into general use. From tables prepared by Consul Clipperton, and which have been sent to the Royal School of Mines, it appears that the total amount of Pennsylvania anthracite coal still to be mined is estimated at 26,361,076,000 tons. The total waste is equal to two-thirds of the coal deposit, and reaches a total of 17,574,000,666 tons, leaving only 8,787,075,333 tons to send to market. For the fifty-eight years comprised between 1820 to 1878, 360,017,817 tons have been sent to market. The consumption now amounts to 20,000,000 tons annually, and the increase of production for the last ten years has been 187,112,857 tons. At this rate the probable maximum mining will be reached in 1900 with 50,000,000 tons per annnum, and the supply will be finally exhausted in 130 years.

NEW CALCULATING MACHINE.

A small appliance, no larger than an ordinary paper-weight, for performing simple arithmetical operations, has been devised by M. H. Beaucourt. The flat rectangular case contains (1) a wheel with a hundred teeth, marked with the figures 0 to 99, both inclusive, one of which appears at a time through an opening; (2) a pinion with wire teeth gearing with it, and carrying a perforated disc through which the fixed figures 1 to 9, both inclusive, are visible; and (3) a second pinion with ten teeth, bearing a dial with the figures 0, 100, 200, 300, &c. The apparatus is so arranged that, by turning the perforated disc, the

consecutive units appear at the opening corresponding to the first-named pinion; and when 99 is reached by the dial of this pinion, one more ninth-part of a revolution of the perforated plate causes a zero to appear at this opening, and 100 at the other. An escapement spring may also be added, to bring back the dials to zero, or they may be so brought back by hand as preferred. The chief use of the invention is for addition, in which case, supposing zero to be shown at both openings, the perforated disc is moved successively round, from right to left, from figure 9 to the figure at the bottom of the column, then to the next, and so on successively, but always starting from 9 on the plate. The successive sums will be registered at one, or, if above 99, at both openings until the total is obtained. The unit figure of this total must be set down, and the tens, or tens and hundreds as the case may be, carried forward by setting them at the units and tens opening before beginning the addition of the second column, which must be performed in the same way as the first. In subtraction, the manipulation is the same, but the direction of rotating the perforated plate must be reversed. It is said that multiplication and division may also be accomplished by the same appliance.

NEW SAFETY LAMP.

M. Tricot, manager of the Mons gas-works, lately brought before the Association des Gaziers Belges a new fixed lamp, invented by M. Lechein, for burning safely while surrounded by an explosive mixture of air and gas, such as may be present in gas-works or petroleum stores; and also for maintaining combustion in an atmosphere charged with smoke and carbonic acid, as in the passages of a burning theatre.

A metal bracket, with orifice in connection with a pipe leading a supply of pure air from a safe distance, is securely fixed to the wall, and is provided with a groove, filled with sand, for receiving a projecting collar at the bottom of the lamp, so as to form an air-tight joint. In the bottom of the lamp is a valve, opening inwards, which keeps it closed until placed in position, when it opens automatically. The cover, made separate for facility of cleaning, is also provided with a sand joint, and the trunco-conical chimney is of such dimensions that no air or gas can enter the lamp by its means; while a sheet of perforated metal or wire gauze, placed across it, affords an additional safeguard. When the source of light is vegetable or mineral oil, the lamp has simply to be lighted, in a pure atmosphere, before being placed in position, as it contains sufficient air to support combustion for two or three minutes, when the air-valve opens. When lighting gas is used, the simplest method is to light a small piece of taper near the burner before fixing the lamp and making the connection with the gas supply pipe; or the gas may be lighted by electricity, or by a fulminating capsule.

Correspondence.

THE SCHOOL CHILDREN OF THE METROPOLIS.

At this time, when an unusual amount of attention is being directed to the subject of primary education, I believe I may be permitted, as chairman of a committee appointed to inquire into the subject of primary education, to give some information as to certain conditions of schools abroad, as well as some special schools at home, for the physical as well as the mental training of children, which, it appears, may be introduced with advantage in the general primary education of this country. And, first, as to the physical conditions prevalent requiring amendment amongst large proportions of the children in the metropolis.

A lady, eminently conversant with the system of physical training in use in the primary schools of Sweden, which is in the course of extension in Germany, and who was engaged to promote the introduction of that system in the London Board schools, stated to us that she found many of the children in the lower districts so squalid, so ill-fed, so weakly, that she was positively afraid to exercise them in the gymnastics for the other children, as they did not appear to have the strength to sustain them. In very pity at the condition of the many she met with, she endeavoured to start a subscription for their relief by food. It may be mentioned that one of the Lady Rothschilds has long contributed, from her pin-money, a donation of nine hundred per annum for the relief, by a meal of bread and milk, of the poor Jews' children attending the Jews' School at Spitalfields. A lady member of the Board has made distinguished exertions to arrest the practice of flogging in their schools. On an observation that there could be no great harm done by it, as it was a practice continued in the superior schools, the objection was met by the statement that, whilst there was no great harm done in those superior schools, great harm was done in the Board schools, where a stripe on the emaciated children was a severe wound, as frequently proved by mothers before magistrates. On the general physical condition of the children in the Board schools, my colleague Dr. Richardson has stated that "It is true to say that it is all but impossible to find in the Board schools of our large towns any semblance, critically viewed, of health. Constitutional taints, which under favourable circumstances may often be concealed, and which may or may not be apparent, are there. Various conditions of disease are there, independently of the tendency from heredity—there of themselves, in some irregularity of body or limb, in some imperfection of sense, in some deficiency of quality of blood, in some

feebleness of respiration, in some nervous irregularity of function, in some shade of mental aberration. The field of disease which is presented in some of the schools situated in crowded localities is indeed a sight at once for anxiety and pity. To the eye of a physician who, like myself, has spent many years in hospital practice, it tells a story which is absolutely painful, if he permits the result to be calculated out in his mind at leisure hours; if, that is to say, he compares what he has witnessed in his survey with what he has learned from long observation of the meaning of the phenomena in the history of life. The practical necessities, as the bases of natural education, call first and foremost in the early days of youth for three elementary practices—of learning to read, to write, and to calculate; but these necessities are comparatively valueless unless they be combined with further necessities of a physical kind—namely, sound and systematic muscular exercise; freedom of breathing and circulation of the blood; practical training, so that the body can be structurally builded up and sustained in health; preparation for all duties requiring precision, decision, presence of mind, and endurance; and readiness to acquire any craft or handicraft that may bring a useful living. In a word, an education that shall bring the mental and physical qualities of every person into faithful harmony and good will."

These dicta as to the common physical condition of masses of children are corroborated by the heavy infantile death-rates, which show that of all born of the wage classes in London, about one half are in their graves by their sixth year. Of some of the Board schools which I have myself visited, comprising the poorer children, I could confidently predicate an excessively heavy death-rate as prevalent in the lower districts from whence they come. Miss Lofving gave an exhibition of the Swedish exercises at one of the Board schools at which the Princess Louise presided, and it excited great admiration. I presided at an exhibition of exercises, the like in principle, though varied in form, given by Miss Chriemans at Exeter Hall. As the exercises went on, I asked Dr. Richardson, who was with me, "What do you consider that exercise good for?" "Oh, that is," he said, "good against narrowness of the chest, and consumption in its early stages"—by which, I may add, more than twenty thousand lives are carried off annually in the metropolis. "And what is that good for?" "That is good against uneven and weak circulation of the blood." "And that?" "It may serve against dyspepsia." And so on with other exercises, which the children were carrying on in high glee, unconscious of anything but the pleasure given by the exercises to music.

Now, in the advanced practice in Sweden with urban children, every child on its admission into the school is diagnosed by the medical officer, who gives a prescription of the specific exercises to be applied. There are large reasons why this example should be followed in this country. In the army, recruits are diagnosed for the preservation of military force by rejection. In infancy, it should be done for the preservation of civil force, by preventive and curative physical training. In the lower urban districts, too large proportions of children are presented, whom a Spartan policy would relieve of a painful existence to themselves and the community; but who, we may now show, may be well preserved in the district half-time institutions for orphan and destitute children, generally of the lowest type; this is done with the greatest proportion of them by sanitation and by bodily exercises, as yet to be further systematised by industrial training, by which the children's diseases of spontaneous origin are almost banished; and the sickness and death-rates in these former sets of epidemics are not now one-third of those generally prevalent amongst the children of Board schools, whilst excepting idiots, full ninety per cent. of the children, by their improved aptitude (by which the efficiency of three is given to every two) for industrial occupations are got into productive service. In the Board schools, filthy-skinned and filthily clothed children are massed together in conditions to generate and spread epidemics. In the primary schools of Holland, some of which I visited with the chief inspector of primary schools, all the children were particularly clean. If in the girls' school the head mistress observed any child to whom the duty of head to foot washing appeared not to have been performed, she directed a *bonne* in attendance to take out the child to a proper apartment, and examine it, and give it the requisite cleansing with tepid water. If the work had to be repeated with the child, it brought discredit on the mother for neglect, and did not continue. The London Board schools are deficient in the appliances for the performance of that service, which is a much larger factor in sanitation than is supposed by school managers, especially for the children of parents, too many of whom have not, in the present condition of water distribution, really the means of providing at home. They are deficient in tepid swimming baths, such as most district schools are provided with. The Rev. Joseph Maskell, master and chaplain of the Emmanuel Hospital, Westminster, in an account which he gives in the *Journal of Education* of a visit of examination he made to the primary schools of Belgium, observes: "I was struck with the neatness of dress and the cleanly appearance of the female children. I saw many signs of poverty in pinched faces, in patched and mended garments, and in coarse texture of dress, but the children were invariably neat and tidy. Every school," he says, "has now its gymnasium, with a special teacher and special times of practice, as part of the regular curriculum. So much importance is attached to gymnastics in Belgium that there is a monthly publication devoted to the interests and operations of this class of teachers, the *Gymnastique Scholiaire*." There is also regular medical inspection of the schools.

At our first general Board of Health we provided, as one of the duties of the medical officers of health,

the regular inspection of the school children; and on the detection of a case of incipent infectious or contagious disease, to direct its removal and follow it home, and see to its treatment there, and also to the sanitary condition of the home, and to its amendment. But this service remains to be applied systematically. It would have stopped the greater number of those epidemics which occasion the closing of schools, for which teachers are asking for compensation for the losses of their fees consequent on the closures. It would indeed have reduced the heavy death-rates prevalent amongst teachers, which are four times greater than amongst seamen in the Royal Navy. The sanitary service required for the schools would have gone against a total loss, as estimated by medical officers, of more than fifty thousand lives in the school stages of life in Great Britain. As respects the physical exercises in the Board schools, Miss Lofving has represented that the long-time system of education occasioned so much obstruction that she could not continue her services efficiently or to her satisfaction, and she has consequently retired, leaving any continuance there may be in the partial school exercises of girls to an inferior service. At the same time, mothers complain before magistrates of the injury it does to them by depriving them altogether of the earnings of their children for the support of their families.

The War Department, on the invitation of the King of Sweden, sent a commission to examine the system of physical training in use there. The reporter, Captain H. Armit, of the Central London Rangers, reports highly and favourably of it, for the gain of civil as well as military forces. The gymnastic college there, he states, has branches in all the principal towns of the country. "By this means the civil and the military schools are connected. A link or bond of union exists in the instructors, who are also sent from the military establishments gratis to all State schools throughout the country. The result is that the whole Swedish population has by degrees been trained and disciplined by means of the Ling system of extension drill, and has thus been accustomed to work, when assembled in large or in small numbers, with an exactitude and a precision of motion hardly credible." He speaks of "the many and great benefits which it confers upon a people, by strengthening the system of the weak and of the robust alike, by infusing health and vigour into the mind, and by teaching to all the value of and the necessity for the existence of discipline amongst all classes of the community. In truth, I may say, the Ling system has made of Sweden a disciplined nation. The introduction of the system would," he says, "cost the taxpayer nothing beyond the salaries paid to the instructors, as no appliances of any sort are required. On the other hand, recruits for the army would present themselves, not as untrained men, but as men proficient in every essential point necessary to form a soldier except the rifle exercise, which latter would not take long to teach them. They begin by the eighth year. It may be added that with a far less favourable climate, the general death-rate in Sweden is about three per 1,000 less than the death-rate in England.

On a review of the London School Board course, it appears that the prevalent majority of the members had not attained to the knowledge of the economy of health and force, and of employing the most effective means of attaining it. They would not give more than half the salary to the professor of physical training that they gave to the head teachers of a very defective system of mental training. The school drill review, for which the Society of Arts gave a prize, had nearly fallen before an opposition of a member of the wage classes, on the ground that it tended to foster a military spirit, in ignorance of the greater fact that it promotes an industrial spirit, and actually raises wages, as displayed in the instance of the wage classes—the volunteers. The schools have been conducted on the common policy, as it were, of rearing two colts to obtain one working horse, which, when raised, has only a limited existence of two-thirds of a healthy period of working ability. Instead of obstructions being removed, and physical training carefully made complete, and made prevalent in all schools, it has only been left to go on in secondary inferior and comparatively ineffective conditions, which all foreign precedents, such as those recited, show, will have to be reformed by superior intervention.

Leaving the difficulty of physical training, affecting most deeply the children of the wage classes, I now beg to advert to the experiences bearing upon the ordinary conditions for mental training in the Board schools.

Those who have given earnest study to primary education are aware that the highest training power should be the most sedulously applied, specially with the lowest classes, in the most formative period o life—the infant school stage. I learn that in the United States great progress is making with the infant schools and the Kindergarten, which is highly popular with educationists there, who reckon it is effecting a saving of two years of school life. It is to be borne in mind as a primary object that all saving of time that can be effected in the earliest school stages is gain of time for the ultimate or secondary stages, from which the great mass of the wage classes, by the time now occupied (as will be seen unnecessarily) with primary education, beyond which they cannot afford to keep their children. It is generally agreed that for the greatest formative power of teaching, the service of ladies should, if possible, be engaged for their most impressionable influence on the manners of the children. It is stated to us by a member of the Board, who has paid special attention to this class of schools, that even now not more than one-half of them have yet attained what is deemed a fitting and effective condition in their appointments. Miss Lofving expresses her regret at finding that, where the highest teaching power should

be applied, she generally found that the supposed least expensive, not to say the most indifferent, was given.

On the next school stage it is usual to put forth the advances made in the passes of the School Board children, but it is omitted to state at what expense of time and of money those passes have been obtained. Of those orphan and destitute children who have been at the Board schools, but who are sent to the district half-time schools, they are found, as a rule, to be far behind in mental attainments the children of the same ages and school attendance in those same half-time schools. In the Board schools very few obtain the Fourth Standard by their tenth year; the great majority only by the eleventh, twelfth, or thirteenth year. In the district half-time schools the mass of the children are got through that standard by their tenth year; in one of the largest by their ninth year, and this with the lowest type of children. Mr. Marsland, of the Anerley School, declares that if he had children of the type of the Lancashire or the Yorkshire children, he would undertake to get them through that standard by their eighth year. But a larger foreign national experience may be cited —that of Prussia, where children are taken into school only by their sixth year, and are passed with more than the British equivalent of the Fourth Standard by their ninth year. Miss Clough, the principal of the Newnham College, Cambridge, was at pains to get over the demonstration of a method, now spreading through Germany, of teaching reading and writing in less than half the time now occupied in the Board schools, but she failed in getting due attention to the subject. Experienced teachers have assured me that if they were left free to use the decimal system, they would teach arithmetic in half the time now occupied with it, and impart a better habit of mind and preparation for higher studies, without detriment to the power of the pupils taking up the duodecimal when they entered upon their technical occupations. Eminent teachers are agreed as to the uselessness of teaching grammar in the earlier school stages. School Board teachers have, moreover, shown to us that if they were left free to use their own course with children of different capacities, the quick and the slow, they would, with the ordinary British methods, and within their own period, after the infant school period, save full two years of the common school life. They verified this by what they had done when their course of teaching was free. Consider the waste of two years of school life to each of half a million of children; of one million of years of school life miserably misapplied, and also the waste of earnings! To this gain is to be added, moreover, the gain of years of school time, by efficient administration in the infant school and Kindergarten period. I do not understand why the expenses of teaching power in the Board schools should be more than double that of the large district schools, the expense of which is not more than one pound per head for inferior teaching power, at higher salaries, and with the expense of drill masters and masters of manual exercises included. It is true that it is not the Board, but the code, which is responsible for the miserable waste of time, and of the children's earnings, and of the rates. But the Board is held to be responsible for ignorance and apathy, and for making no exertions to rouse the attention of Parliament to a double expenditure of the rates with inferior results.

It may be useful to mention that the half-time principle has been recently adopted by the Municipality of Paris for its primary schools, and that it has also been adopted in the new educational code for all children engaged in agriculture and in manufactures, which will include the great mass of the children of France. Its systematised extension in this country was recommended by the Commissioners on the Factories and Workshops Regulation Acts.

On a review of the work of mental training in these Board schools, it is observable that it displays a lack of knowledge of the very basis of a sound system—namely, of the limits of the mental receptivity of children of the average ages being generally exhausted, by direct simultaneous class teaching — the only effective teaching—in less than three hours; all sedentary constraint beyond that, usually of five or six hours, during which work is going on, with most miserable and detrimental waste of time and money. Where the limits of the mental receptivity are unknown, undistinguished, and disregarded, the very foundation of the efficient and economical administration of educational funds are unknown. We have the consequences displayed in wearisome efforts, as it were, to get quarts into mental capacities of pints, and of gallons into quarts, with prolonged sedentary detentions for the purpose, and grievous bodily as well as mental injury. One fundamental rule that would in itself effect an entire change in teaching, with adaptation to the mental receptivities of children, would be that no lesson should be allowed to be given that had not been tried in different classes and conditions of children, and had been found to sustain the attention of all to the end, by its own interest. In the place of a policy of sedulously accommodating learning to earning, in the case of the poorest of the wage classes, the common policy is carried on—to a most grievous and pernicious extent—of sacrificing earning to learning.

It should be stated that the school teachers, as a body, are far from concurring in the congratulations on the working of the present system. Mr. Morrison, the head of the Free Church Training College at Glasgow, states it as the general experience of the elementary school teachers in Scotland, that the pressure brought by it upon children "is very great, and that the time required to be made up with very young children leaves scarce time for play and healthful recreation," and that on the whole it is detrimental "morally, mentally, and physically." The President of the National Union of Elementary Teachers of Schools of all Denominations in Great Britain (one of the head teachers of the London

School Board), in his recent address, enlarges upon these evils, on which, with others, they have been promised a hearing in Parliament; and he stated that "the pale faces, lack-lustre eyes, aching brains of the little children, and the repeated complaints of brain fever, loss of eyesight, and bodily depression and weakness, plainly evince the cruelty as well as the senselessness of the system."

EDWIN CHADWICK.

East Sheen, Mortlake, Oct. 30, 1882.

Obituary.

LORD OTHO FITZ-GERALD.—The Right Hon. Lord Otho Fitz-Gerald, a member of the Council of the Society, died suddenly at his residence, Oakley Court, Windsor, on the 19th inst. He was the fourth son of the third Duke of Leinster, and was born in 1827. He served for some years in the Royal Horse Guards, and from 1866 to 1874, he held the office of Comptroller of the Queen's Household, in Mr. Gladstone's first administration. His Lordship was elected a member of the Society of Arts in 1864, and was a frequent attendant at its meetings. When elected on to the Council at the last annual meeting, he publicly expressed his warm interest in the work of the Society.

EARL OF HARROWBY.—Dudley Ryder, second Earl of Harrowby, K.G., who died on the 19th inst., at Sandon Hall, Staffordshire, in his 85th year, was for many years a member of the Society of Arts. He succeeded his father in 1847, was created D.C.L. by the University of Oxford in 1848, and elected a Fellow of the Royal Society in 1853. In the last-named year he became a member of the Society of Arts, and was for several years a vice-president. He acted as Chairman on the occasion of the meeting for the discussion of the late Dean of Hereford's (Mr. Dawes) paper "On the Importance of Giving a Self-supporting Character, as far as possible, to Schools for the Working Classes" (May 4, 1853). In the following year he presided when Mr. Leone Levi's paper on "The Importance of a Correct System of Agricultural Statistics" was read. The late Earl held, at various times, several important offices, both in and out of the Cabinet.

SIR HENRY WILLIAM RIPLEY, BART. — Sir Henry Ripley, who died on November 16th, at his residence, Bedstone Court, Shropshire, had been a member of the Society of Arts since 1856. He was born in 1813, and became, on the death of his father, senior partner in the firm of Edward Ripley and Son. He was a Member of Parliament for Bradford from 1874 to 1880, and, in the latter year, he was created a Baronet.

General Notes.

AMSTERDAM INTERNATIONAL EXHIBITION.—The Executive Committee have enlarged the building for this Exhibition, and an increased space is now allotted to the British section. An extension of time for applications has also been accorded.

VANADIC ACID FROM BLAST-FURNACE SLAG.—Messieurs Osmont and Witz have obtained considerable quantities of a special product, called vanadic acid, by heating the slag yielded in the process of dephosphorising a certain class of pig, at Creusot, by the Thomas-Gilchrist process. The acid is obtained by the reaction of oxygen on the vanadium, and, by treating it with hydrochloric acid, a beautiful green pigment is obtained, which is very valuable, and may be used directly in dyeing.

PROPOSED MEMORIAL TO TREVITHICK.—A meeting was held on Wednesday, November 15th, in the rooms of the Society of Arts (Mr. Hyde Clarke in the chair), to consider the means to be taken for the purpose of commemorating next year, the fiftieth anniversary of the death of Richard Trevithick, the inventor of the high pressure engine. It was resolved —"That, in the opinion of this meeting, next year being the fiftieth anniversary of the death of Richard Trevithick, it should be commemorated by some permanent memorial; and that the following gentlemen form the committee, with power to add to their number:—Messrs. Hyde Clarke, F. W. Webb, H. Chapman, W. Husband, H. Trueman Wood, Professor Pole, Captain John Davis, and Frank Harvey." Captain Davis was appointed honorary secretary.

COLONIAL LIGHTHOUSES.—A recent Parliamentary paper gives the dues received and the expenditure incurred in the construction, repair, and maintenance of lighthouses in British possessions abroad during the year 1880-81. For the Cape Race light dues, £4,378 5s. 2d. was collected in ports of the United Kingdom, £29 7s. 3d. at St. John's, Newfoundland, and £206 17s. 6d. in Canadian ports. The maintenance of the lighthouse and fog whistle cost £1,571 3s. 6d. The balance in hand, including the amount brought forward from the previous year, is £5,415 7s. 3d. The dues collected for the Great and and Little Basses lights were as follows:—Bombay, £997 9s. 2d.; Burmah, £1,231 9s. 9d.; Calcutta, £5,353 3s. 4d.; Ceylon, £1,318 16s. 3d.: Kurrachee, £4 13s. 5d.; Madras, £431 12s. 11d.; Mauritius, £125 14s. 8d.; Penang, £124 1s. 1d.; Singapore, £1,783 4s. 10d.; and ports in the United Kingdom, £3,387 19s. 11d. Maintenance cost £3,702 13s. 3d. The year commenced with a balance of £11,530 13s. 6d., and closed with a balance of £15,266 8s. 6d. The amount due to the Public Works Loans Commissioners, however, on account of the last-named lights, is £100,700.

COAL PRODUCTION.—According to the Wurtemberg *Gowerbeblatt*, the coal production of Germany has so enormously increased within the last two decades, that there is reason to fear an exhaustion of the beds at no very distant date. While the production of England, in that period, has risen from 85·4 million tons to 149·3 million; that of France, from 8·3 million to 19·4 millions; that of Belgium, from 9·6 million to 16·9 million; the German yield of coal has increased from 12·3 million to 58·9 million—a proportion reached approximately only by North America, which shows a rise in production from 15·2 million to 70·3 million tons. Considering that the coal-fields of Belgium comprise about 900 square miles; those of France, 1,800; those of Germany, 3,600; those of England, 9,000; and comparing with these the vast coal-fields of the East Indies, 35,000 square miles; North America, 193,870 square miles; and China, over 200,000 square miles; the question of so improving means of international traffic that the small cost of transport may render possible a continuation of industrial work on European soil with foreign coal, becomes—in the opinion of the writer referred to—most important.—*Engineer*.

CALIFORNIAN VINEYARDS.—There has been an enormous increase in the size of the vineyards in California. Not long ago a plantation of 200 acres was regarded as a very large vineyard, but now vineyards of five or six hundred acres are to be frequently met with, and one of not less than 1,500 acres has just been planted near Los Angeles. It is the opinion of a practised agriculturist that in the course of three years or so California will be able to boast of vineyards embracing five or six thousand acres each. The total number of acres at present under vine culture is estimated at about 100,000, all of which will be bearing in four years' time, with a possible production of from forty to fifty million gallons yearly. The price of wines at the vineyards varies according to quality of grapes and the location of production. New wines are sold at twenty to fifty cents a gallon for dry wines, red or white; sweet wines range from fifty-five to seventy-five cents a gallon. The entire product of last year's vintage was 9,000,000 gallons, but more than one-third was destroyed through frosts. While the outlook for next year's crop is very good, it is stated that last year's prices for grapes will not be maintained, as the cellars of San Francisco are full, and prices in the Atlantic States are too low to pay for transportation thither. —*The Times*.

ALTERATION OF MEETING.

It has been found unavoidably necessary to postpone the reading of Sir Frederick Bramwell's paper, on "Some Points in the Practice of the American Patent Office," until after Christmas. Due notice will be given when the date for reading is fixed.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock :—

NOVEMBER 29.—"Collisions at Sea." By CAPT. J. H. COLOMB, R.N. SIR FREDERICK BRAMWELL, F.R.S., will preside.

DECEMBER 6.—"The Artificial Drying of Crops." By WILLIAM A. GIBBS.

DECEMBER 13.—"Electrical Exhibitions." By W. H. PREECE, F.R.S.

DECEMBER 20.—"The Utilisation of Waste. A Quarter of a Century's Progress." By P. L. SIMMONDS.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 27...Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. "M. Lessar's Reconnaissance Survey from Sarakhs and Merv to Herat," with Remarks by Major-General Sir Henry Rawlinson.

Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Presidential Address by the President, Mr. T. B. Sprague, M.A.

Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, Nov. 28...East India Association, at the Pall Mall, Regent-street, W., 3 p.m. Mr. H. M. Hyndman, "Why Should India Pay for the Conquest of Egypt?"

Law Amendment Society, 1, Adam-street, Adelphi, W.C., 8 p.m. Right Hon. Sir Arthur Hobhouse, "How far should Property given to Public Uses be controlled by Public Authority?"

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. "American Practice in Heating Buildings by Steam," by the late Mr. Robert Briggs.

National Indian Association, 11, Chandos-street, Cavendish-square, W., 8 p.m. Dr. Frances Hoggan, "Medical Women for India."

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. Dr. G. W. Parker, "The Language and People of Madagascar."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Prof. Owen, "The Sternum of *Notornis* and its Sternal Characters." 2. Mr. F. Day, "The Identity of *Amoglossus lophotes*, Günther, with *A. grohmanni*, Bonap." 3. Dr. A. B. Meyer, "International Colour-scales for Scientific Purposes."

WEDNESDAY, Nov. 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Captain J. H. Colomb, "Collisions at Sea."

Royal Society of Literature, 4 St. Martin's-place, W.C., 8 p.m.

THURSDAY, Nov. 30...Royal, Burlington-house, W., 8½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

FRIDAY, Dec. 1...Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m.

Journal of the Society of Arts.

No. 1,567. Vol. XXX.

FRIDAY, DECEMBER 1, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Thursday, November 23, at 4.15 p.m. Present:—Mr. Andrew Cassels (in the chair), Sir George Birdwood, M.D., C.S.I., Lord Alfred Churchill, Mr. Hyde Clarke, Mr. F. Hendriks, Sir W. Rose Robinson, K.C.S.I., Mr. J. T. Wood, with Mr. H. Trueman Wood, Secretary, and Colonel Hardy, Secretary of the Section. The programme of papers to be read during the present session was discussed.

ADJOURNMENT OF MEETING.

On Wednesday evening last the discussion on Captain Colomb's paper, on "Collisions at Sea," was adjourned until to-night (Dec. 1) at 8 o'clock.

Proceedings of the Society

THIRD ORDINARY MEETING.

Wednesday, November 29, 1882; Sir Frederick Bramwell, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Ash, William Henry, Porthcurno, Penzance.
Carr, Lieut. George Anderson, R.E., Brompton Barracks, Chatham.
Focking, A., 15, Bayswater-terrace, Bayswater, W.
Gribble, Charles Risdon, 6, Adam-street, Adelphi, W.C.
Gordon, Joseph, Reform Club, S.W.
Laing, David, 2, Duke-street, Adelphi, W.C.
Sharples, Charles Heaton, 2, Latham-street, Preston.
Shearman, Henry Franklin, 15, Linden-gardens, W.
Siemens, Alexander, 12, Queen Anne's-gate, S.W.
Tamburini, Joseph Sylvius, 1, Gray's-inn-square, W.C.

The following candidates were balloted for and duly elected members of the Society:—

Annable, William, 3, Brighton-place, Govan, Glasgow.
Ashbee, Henry Spencer, F.S.A., 46, Upper Bedford-place, W.C.
Aylesbury, Commander Thomas William, The Elms, Sutton, Surrey.
Benvenuti, Fortuné François, Gore-house, Gore-terrace, Swansea, South Wales.
Borradaile, Thomas Salkeld, 7, Union-court, Old Broad-street, E.C., and Nya Ghur, Surbiton, Surrey.
Boulton, Samuel Bagster, 64, Cannon-street, E.C., and Copped-hall, Totteridge, Herts.
Brougham, Hon. Reginald, British Electric Light Company, Heddon-street, Regent-street, W.
Brown, Richard, 12, St. James's-road, Liverpool.
Carpenter, William Lant, B.A., B.Sc., F.C.S., 36, Craven-park, Harlesden, N.W.
Cates, Arthur, F.S.A., 12, York-terrace, Regent's-park, N.W.
Cathcart, Charles H., Cressingham-grove, Sutton, Surrey.
Church, Henry J., H.B.M. Pro-Consul, Halsörn, Vessen, Nordland, Norway.
Clarke, Stephenson, Croydon-lodge, Croydon.
Cooke, John, Howe-villa, Richmond, Yorkshire.
Davis, Thomas Sebastian, 3, Lansfield-terrace, South Lambeth-road, S.W.
Dearnaley, Irvine, Handel-place, Ashton-under-Lyne.
De Soyres, Francis Johnston, 6, Arlington-villas, Clifton, Bristol.
Dorman, Thomas Phipps, Billing-road, Northampton.
Durrant, Edmund, High-street, Chelmsford.
Elliott, Thomas William, 26, Tavistock-square, W.C.
Farrer, Thomas Henry, Abinger-hall, Dorking.
Formby, John, Heaves, Milnthorpe, Westmoreland.
Forster, Stuart, Binfield-house, Bracknell, Berks.
Fosbery, Lieut.-Colonel George Vincent, Upton-house, Bitton, near Bristol.
Gaddes, Thomas, 46, Seymour-street, Portman-square, W.
Godwin, James, 61, Stoke Newington-road, N., and Leadenhall Market, E.C.
Gough, Mrs., Willenhall, near Wolverhampton.
Gregory, Edward, 101, Guildford-street, Russell-square, W.C.
Hallett, John Harry, 120, Powell's-place, Bute Docks, Cardiff.
Hamilton, Frederic Adam, Halifax, Nova Scotia.
Harding, Thomas Richards, Tower Works, Clo[illegible]e-road, Leeds.

Hawker, Lieut. E. C. Tyrell, R.E., H.M.S. *Hood*, Chatham.
Herman, Henry, 5, Keppel-street, W.C.
Hopkinson, John, D.Sc., M.A., F.R.S., 4, Westminster-chambers, S.W.
Howell, Jonathan, Birnam-villas, 10, Tollington-park, N.
Jensen, Jens, 17, Fairfield-road, Birkenhead.
Kemp, Mrs., Widmore, Taunton, Somerset.
Kitching, John, Oaklands, Kingston-hill, Surrey, and Elm Field, Darlington.
Lake, Henry Harris, 8, Southampton-buildings, W.C.
Morris, James, D.Sc., Bourtreehill, Uddingston, Lanarkshire.
Moss, Henry, Parmiter's School, E.
Nightingale, James E., Wilton, Salisbury.
Park, William Charles Cunningham, 25, Lime-street, E.C.
Pielsticker, C. M., 5, Sidney-terrace, Kilburn, N.W.
Reckenzaun, Anthony, Leytonstone, E.
Reid, Walter Francis, F.C.S., Stowmarket.
Routh, Thomas Alfred, 52, Beaumont-street, Marylebone, W.
Ryall, William Bolitho, 24, Warwick-lane, E.C.
Ryan, John, B.A., Warwick-house, Maida-vale, W.
Schofield, Christopher James, Whalley-range, Manchester.
Sheldon, E. L., 13, Clement's-lane, Lombard-st., E.C.
Simon, Henry Gustavus, Darwin-house, Didsbury.
Simonds, William Turner, Ivy-house, Skirleck Quarter, Boston, Lincolnshire.
Stafford, Marquis of, M.P., Stafford-house, St. James's, S.W.
Teague, William, jun., Pool, Cornwall.
Vesey, Arthur Henry, The Grange, Knockholt, Sevenoaks
Watson, Joseph, the Attorney-General's-chambers, New-court, Temple, E.C.
Watt, William, 20, Grafton-street, W.C.
Wigg, Charles, Halton-lodge, Runcorn, near Liverpool.
Wing, Thomas W., 83, Piccadilly, W.
Wrench, Robert, Gilamont, Maple-road, Surbiton.
Wright, Frank, 128, Osborne-road, Forest-gate, E., and 80, Gray's-inn-road, W.C.

The paper read was—

ON SOME OF THE CAUSES OF COLLISION AT SEA.

By Captain P. H. Colomb, R.N.

The Wreck Register, as it is familiarly called, gives us a yearly summary of the collisions reported during the twelve months, varying the form in several different tables, and in one, giving a classification of the assumed causes.

According to this official statement for the year 1879-80, there were 522 collisions reported off the coasts of the United Kingdom, of which the causes were assumed to be known, and these are stated as follows :—

Per cent.	
9	Parting cables, dragging anchors, &c.
1	Missing stays.
1	Anchoring in foul berth.
6	Want of sea room.
14	Thick weather.
11	Bad look out.
5	Neglecting to show light.
16	Neglect or misapprehension of rule of the road.
3	Error of pilot.
0	Want of seamanship.
12	General negligence and want of caution.
10	Inevitable accident.
12	Error in judgment.

We may roughly separate these assumed causes into two classes: those, namely, which are blameless, and those which are blameworthy. The latter embrace 60 per cent. of the whole, and include "anchoring in foul berth," "bad look out," "neglecting to show light," "neglect of rule of the road," "error of pilot," "general negligence," and "error in judgment."

Those causes where no blame is implied are—"parting cables, and dragging anchors," "missing stays," "want of sea room," "thick weather," "inevitable accident." These comprise the remaining 40 per cent. of the causes assigned.

It will be apparent, that there is some unsatisfactoriness about this arrangement of causes, inasmuch as many of them overlap and include others. "General negligence," if it can be pronounced upon at all as a cause, must be capable of separation into particulars coming under the head of "not showing light," "bad look out," "neglect of rule of the road," and so on. The "error of pilot" must be some particular error, possibly "anchoring in foul berth," possibly "disobeying the rule of the road." The "error in judgment" must likewise come under some other specific head.

Then, there is a further want of clearness in placing in the same category the causes—which are properly the preventible causes of collisions—and the conditions under which they happened. If we say that a collision happened through "bad look out," for instance, we may insist on a better look out, and so remove a preventible cause. But if we say the cause was "thick weather," or "crowded navigation," these are conditions

over which we have no control. They are not the causes of the collisions, but the conditions under which they happened. If everything was done to avoid collision which was possible under the circumstances, the collision was an "inevitable accident." If anything was omitted, or if any wrong act was done, that omission, or that wrong act, might have been the cause of the collision.

But there are much graver objections to this system of assuming causes than any which can be drawn directly from the tables themselves. Anyone who will take the trouble—and there is no doubt about the trouble—to master the evidence given in collision cases, will know that there is, in nine cases out of ten, the greatest possible difficulty in duly apportioning the blame. Seldom can it be done without a very full and calm examination and weighing of evidence tendered by both parties to the collision; and, after this full examination, it is by no means uncommon to find the Court of Appeal totally upsetting the decision of the Court below. But to take, as must be done in most of these cases, simply the opposing and generally apparently conflicting statements of a single witness on each side, and apportioning blame thereon, cannot be other than a fallacious undertaking.

Lawyers who do their business in what happens in the great waters, are astonishingly sceptical as to the reliability of nautical witnesses, and the quiet wink which accompanies their statement of what is called the "settlement" of a case before it goes into Court, is wonderfully expressive of their private opinions.

I do not myself agree in the broad accusations of hard swearing which are hurled at nautical witnesses in collision cases, though I admit that there must be reticence on damaging points, in cases involving such heavy stakes as the ordinary collision of two ships. But I know that the process of making a complete story out of the disjointed testimony of the two ships, is so like fitting together the parts of an exceedingly complicated dissected map, that it is a mere measure of relief from drudgery, to reject masses of direct testimony as so much direct falsehood.

But this being so, it must be fallacious to tick off the causes of 500 or 600 collisions as the Wreck Register attempts to do, and so say that a "bad look out" was the cause in one case, "missing stays" in another, and "inevitable accident" in another. It must be doubly fallacious if we recognise the truth that collisions rarely spring from any single cause, but are generated by the concurrence of several antecedent conditions, the absence of any one of which might have obviated the accident.

Thus I must say frankly, that I do not think that anything like 60 per cent. of the collisions are due to what may be generalised under the term, the "moral obliquities of seamen," nor do I, on the other hand, think that anything like 20 per cent. are due to "want of sea-room," and to "thick weather," just as little am I disposed to admit 10 per cent. of the collisions to be "inevitable accidents." Some are, no doubt; but I feel satisfied that a great many which are even so classed by the Courts, might have been avoided, had steps which were clearly proper on the face of matters been taken.

There is an apparent contradiction in this latter statement with what was said immediately before it, which must now be explained. I think there are general and wide-spread misapprehensions as to the causes of collisions, and that they can be shown to be due to those misapprehensions. Acting under them, our authorities have given us a series of laws, or rules of the road, which are fatally faulty and dangerous; while the seamen, under the same misapprehensions, and in part compelled by the faulty laws, cause the ships to act in ways which directly lead up to collision. In so doing they either draw no distinction, between what are safe, and what are dangerous movements, or else they deliberately choose the dangerous movement under the impression that it is the safest.

When I began the study of these questions, now some five-and-twenty years ago, it struck me as strange that I could not find that there had ever been any inquiry into the circumstances preceding collision. No one appeared to have put the questions, Do ships come into collision equally under all conditions and circumstances, or are there only certain conditions which precede them? Do ships approaching each other from all directions equally come into collision, or are there some directions of approach which are more productive of collision than others? Do all movements of the helm equally precede collision, or are there some movements which are more often precedent of collision than others?

These are the questions which an inquiry into the causes of collision should be made to answer, and on the answers, it is manifest, the laws, appliances, and the general instructions

which our seamen receive should rest. Yet, up to this time, no such authoritative inquiries have ever been made, and no answers whatever have been given authoritatively to the questions.

In framing the rules, and arranging the appliances for avoiding collision, no experiments have been made, and no statistics or other data have been used. It has always been considered sufficient to rest on the opinions of a few seamen—most of whom have, perhaps, never fully studied a collision case—civilians, or lawyers; and rules and appliances grow, as it were, out of these opinions, to be right or wrong as other opinions shall afterwards dictate. The result has been, that we are always changing the rule of the road, and the appliances. Since 1840, when certain rules for steamers were first formulated, there have been four great changes in the rules, besides several minor ones, and each of the great changes has been a complete sweeping round from one set of principles to another set, sometimes totally opposite; and latterly, the rules have grown so complex that they extend to twenty-six articles, some of which contain several subsections, and the whole covering many pages.

If it were possible to accept any general cause, such as the Wreck Register gives us, it might be quite plausibly argued that the cause of collisions, which were not inevitable, was the complexity of the law. But as this is altogether an unsatisfactory process, we may return to the more satisfactory questions which may be expected to lead us up to the particular causes, and, very possibly, show us how they may be removed.

The sources of information are fairly complete, and quite accessible. In the Registry of the Admiralty Court, are long ranges of volumes containing reports, and often very full verbatim reports, of the collision cases which have been tried there; and when a sufficient number of these are examined and classified, the answers given to our queries come out with great force and clearness.

It may be repeated that these records would very probably fail us, if we attempted a new apportionment of blame to either side. So also might this fail us if we attempted to pick out from the surrounding conditions a single one, and say that, and none other, was the cause of that collision. But taken simply to establish the conditions under which collisions occur, and the movements which precede them, they form a very satisfactory body of evidence.

It is generally understood, and is most clearly borne out by the evidence, that the large majority of the collisions, and almost all the disastrous ones, happen at night; most of them in clear nights, and usually when each ship has seen the other at some distance, and at some time before the collision. It is not singular that collision, under such conditions, should be at once set down to moral obliquities on the part of the seamen in command of the ships; but it is not fair to do this until we have distinctly decided that no blame attaches to the rules which the seamen have obeyed, or tried to obey, or to the teaching which they have authoritatively received.

I will give a single, but most remarkable and startling illustration of my meaning. It is well-known that all, or nearly all, ships carry at night, when under way, certain lights, coloured green or red, with the view of enabling each to avoid the other. Now, matters are so arranged that whenever the commander of a steamer sees the red light of another steamer in such a direction as to indicate danger, he is, by the same signal, deprived of all guidance. If he asks authority, "Ought I to stop in this case?" authority gravely answers, "Yes; if it is not your duty to go on." If he asks, "Should I turn towards this red light in order to avoid the steamer carrying it?" authority answers, "Yes; if it is not your duty to turn away from it." It is forgotten that a red light is only a red light, and can but convey the meaning attached to such a signal. But the law actually stands to say that there is the signal—a red light—and it would be quite beyond the province of the law to define its meaning. You must, for yourself, come to some decision as to what it commands when you see it, and when it announces danger. The law will punish you if the decision you take turns out to be wrong, but it has no idea of warning you beforehand what *is* right and what *is* wrong under these circumstances.

In order to come to a decision, we proceed to show the further conditions which precede collision. Referring to Fig. 1, we have a graphic representation of where lights first appear in reference to any ship, X, which afterwards gets into collision with the ship bearing the light. The diagram is the result of 578 reports of lights seen previous to collision; and it shows us it is an ordinary precedent of collision that the light should be seen a little to the right or left of the direction in which the ship is proceeding. Only 41 instances out of the whole stand recorded in

which the light was first seen more than 4 points of the compass, or 45° to the right or left of the direction of the ship's course. That is but 7 per cent. of the whole cases. Again, only in 20, or in 3½ per cent. of all the cases, was the light first seen abaft the beam, that is, in a direction at more than 90° to the ship's course.

If these facts are borne out on a larger examination of data—which there is great reason to believe they would be—it will follow that, as 93 per cent. of all the collisions at night happen after a light is seen, not more than 45° to the right or left of the course, it is this condition which ought to be considered in applying the remedy. The remaining 7 per cent. may legitimately be left out of consideration, unless it is quite certain that any rules we make for the 7 per cent. will in no way interfere with or confuse those we make for the 93 per cent.

Referring now to Fig. 2, we find that out of 295 cases of collision at night, only 76, or 26 per cent., occurred when the original courses had crossed at a greater angle than 45 degrees, or four points of the compass; and in only 24 cases, or in 8 per cent., did they cross at more than a right angle. Thus we may be sure—if the figures are sustained on a still wider range of statistics—that the normal collision at

FIG. 1.

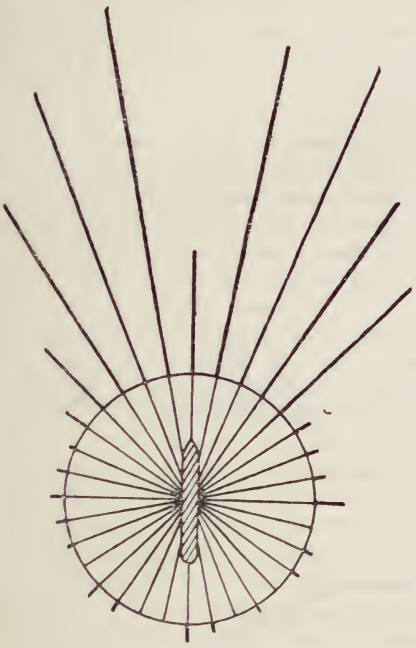


FIG 2.



FIG. 3.



night, against which we ought to provide—by an investigation of the causes, and by the application of a remedy—takes place when one ship sees the light of the other a little to the right or left of the direction in which she is steering, or when both ships see one another's lights in this position. Further, the courses of the ships bearing these lights will cross at a small angle. That is to say, the normal conditions preceding collision, are, so far as the position of the ships go, those shown in Fig 3.

This normal set of conditions may become more strikingly apparent if we confined our view to the disastrous collisions. It appears to be quite rare for a disastrous collision (excepting, of course, those which happen between ships of the same fleet) to arise out of any other mutual positions than those given in Fig. 3.

Now, let us just for a moment consider what is the natural impulse of a man in command of the ship X, if he sees the light of Y to his left and a-head, as in the figure, and is alarmed at what he considers an approaching danger. It is, of course, to turn away from the danger. Without arguing the point just now as to whether this is a right or a wrong step to take, and supposing the men in the ships to be utterly ignorant of all rule of law, let us just remember that this is the natural impulse of a

FIG. 4.

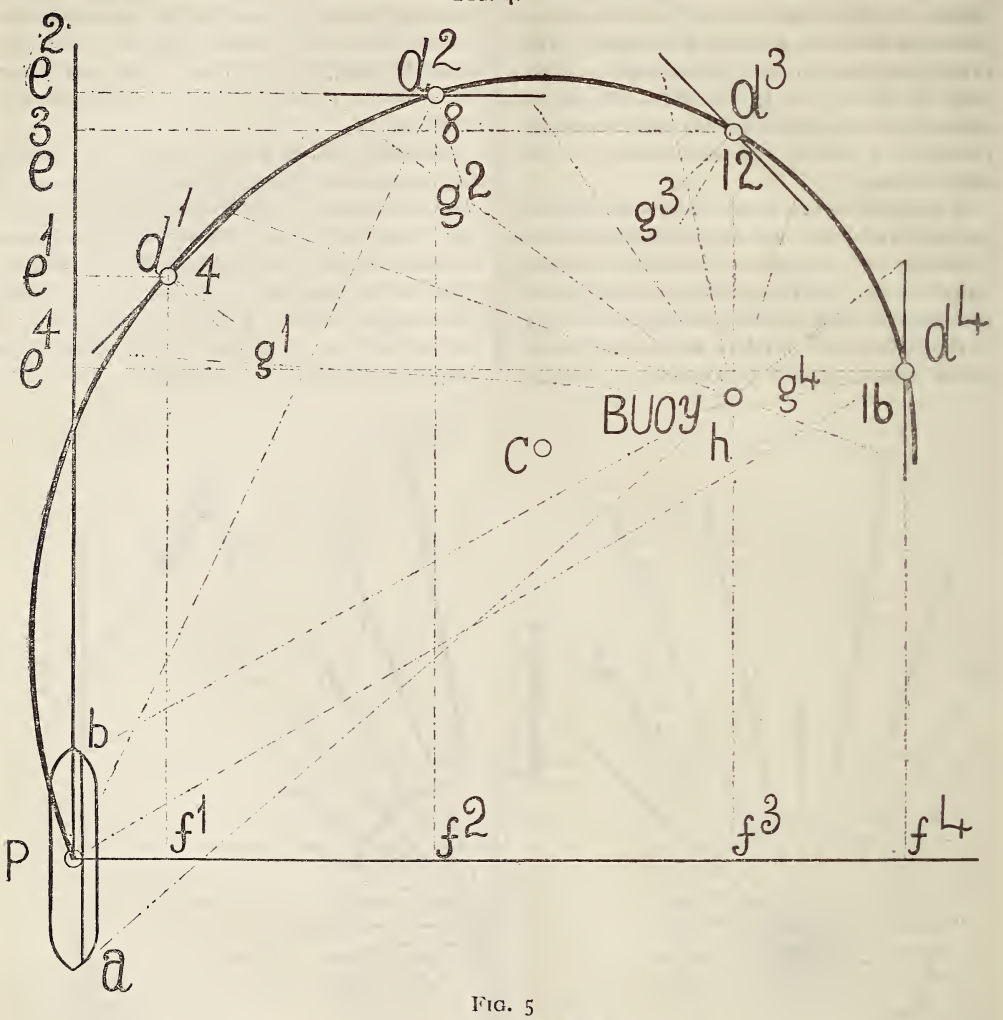
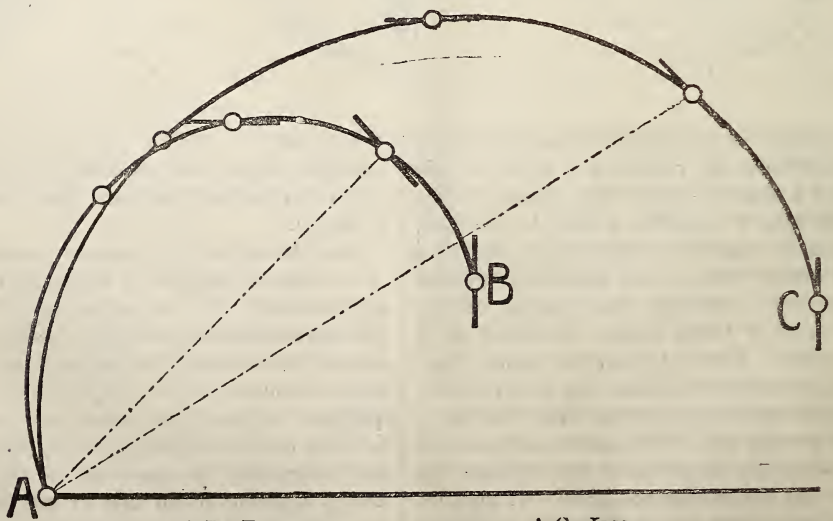


FIG. 5



A B—THUNDERER. A C—IRIS.

man in X, alarmed by the appearance of the light of Y. Just so is it if we suppose a fog, and that X hears the sound of Y's fog-signal, the natural impulse is to turn away from it. It is, of course, the same for Y seeing the light, or hearing the sound-signal of X, the impulse is to turn away from it. Not only is this impulse so, but experienced seamen are under the impression that the impulse is a just one, and that this turning away from the danger is a safe and seaman-like proceeding.

The nautical world has been confirmed in this view by the large circulation of authoritative explanations of the rules of the road, which expressly sanction this turning away from an apparent danger. Lastly, a powerful committee, which sat to devise remedies for the dangers of Thames traffic, after the unhappy destruction of the *Princess Alice* and 600 lives, by direct recommendation, by inference, and by the questions and observations of its members, very thoroughly confirmed nautical opinion. So that there is no doubt but that we ought to expect to find this turning away from the light seen, a common precursor of collision—unless, indeed, it were so safe a movement as to generally avoid collision; and then we should expect to find the majority of collisions preceded by the other movement, the turning towards the dangerous light. The fact, however, is, that a turning from the apparent danger by one or both ships is almost invariably the precursor of collision; while a turning towards the apparent danger by one or both ships is, it may almost be said, never a precursor of collision.

On this pretty-well established set of conditions, the question arises whether this turning away from an apparent danger is, in itself, a movement to be recommended, or, indeed, a movement on any grounds to be permitted, seeing that it is generally preliminary to collision? To answer this question, we leave statistics, and appeal to experiment.

About twenty years ago, the growing length and tonnage of the steam war-ship brought into relief the limits which length and other conditions placed on the manœuvring powers of ships generally. Notes were taken of the time which elapsed during which ships turned through given changes of course, or were brought to rest from a given speed. These times were found to be very much longer than was expected, and by consequence it was understood that the spaces traversed in turning and in stopping were much greater than had been supposed. Methods of measuring the spaces, more or less accurate, were adopted, and for many years past war-ships of all classes have had the times and spaces occupied in turning through definite changes of course tested and recorded. Quite recently, considerable improvements have been effected in the methods of measurement, so that we are able to exhibit, for any ship which has been experimented on, a fairly exact trace of the track she pursues in turning through any number of points of her compass, up to sixteen, or 180°.

Fig. 4 (p. 40) is such a trace, to a scale of lengths of the ship shown, the ship in this particular case being one of the handiest afloat—a twin screw, with a large rudder area, a good helm angle, and steam steering gear, by which the helm can be put over, while the ship advances her own length at 10-knot speed.

In Fig. 5 (p. 40), this trace is compared with that of another ship, ostensibly of average manœuvring power, but probably of rather worse manœuvring power than usual. There is reason to suppose that the turning powers of the great majority of ships will be found between these two extremes; that few (if any) ships can turn by the use of the helm alone, inside the path marked for the *Thunderer;* and that most ships can turn on the path marked for the *Iris*, or on one within it, yet outside that of the *Thunderer;* these paths being, of course, proportional to the length of the ship.

Single screw ships and sailing ships, when off the wind, have no further powers of reducing time and space they occupy in turning. But twin-screw ships can, by management of their screws, considerably decrease the space they ordinarily turn in, when large changes are concerned. They can only very slightly influence their turning powers through changes of course under 45°, as may be seen by reference to Fig. 6 (p. 42), where the outer largest course is made with both screws working ahead; the next, with the inner screw, stopped at the moment the helm begins to move; and the smallest, with the inner screw, stopped and reversed as soon as possible after the helm begins to move.

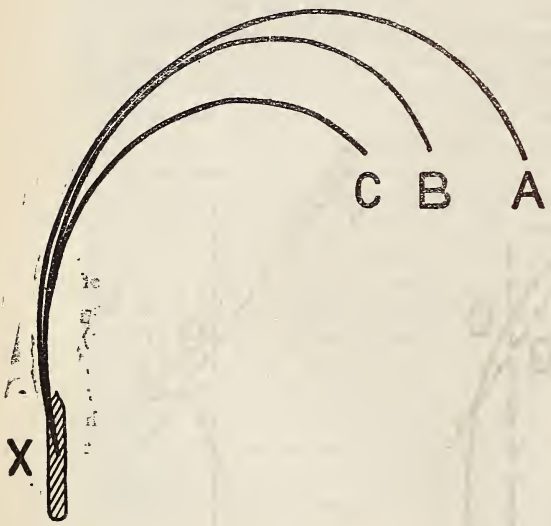
Sailing ships near the wind can, by the management of their sails, do a good deal towards decreasing the time and space they require to turn in, and, in the old books of seamanship, these modifications were reduced to a complete science.

Reverting now to Fig. 3, and taking with us the knowledge we have gained of the paths

which these ships, X and Y, must follow in turning either to the right or left, by the movement of their helms, we shall be in a position to pronounce, with some decision, on the relative safety of the two turns which alone are possible to either ship.

But we must first note the conditions under which collision is possible between X and Y. The point O is called the collision point, and if the ships reach this point near about the same time, there will be a collision. Therefore,

FIG. 6.



there is a *prima facie* case in favour of collision, when either X or Y sees her neighbour in or near the positions shown. To make a collision certain, the speed of X must be great enough to permit her bow to reach the collision point before the stern of Y has passed it, yet not so great as to have allowed her stern to have passed the collision point before the bow of Y has reached it. But if the relative speeds be within these limits, there will be a collision, unless one or other ship takes some steps to avoid it.

This avoidance may be made without the use of the helm on either part, if there is time and space enough to increase the speed of one ship and decrease that of the other, until the difference is outside the limits already mentioned. But such control over the impetus of vast masses, weighing thousands of tons, requires much time and long space for its exercise. The helm rightly applied, is a much more powerful instrument in the avoidance of collision, and it is that almost universally appealed to at sea.

Suppose then, fearing a collision, under the *prima facie* case of risk, which is apparent to her, Y (in Fig. 7, p. 43) alone proposes to avoid X by turning away from her. If she is a very handy ship she may turn along the path Y Q. But this does not apparently produce any considerable effect on the general situation; if anything, the danger has been somewhat increased, as we shall presently see more clearly. But it is, in any case, pretty certain that if a collision would have occurred before, it will equally occur now, in spite of Y's effort to avoid it.

In Fig. 8 (p. 43), we suppose that Y makes the turn towards X; but here, though it can be said, and will presently be demonstrated, that the case is made no worse by the turn of Y, it can hardly be said to be much better. If a collision is due originally, it is almost equally due now, in spite of this effort of Y. So that we are in the midst of a case where it is utterly impossible for Y, though equally handy with X, to avoid a collision, unless X in some way assists.

Let us pause for one moment, to state that, in the vast majority of cases of this nature, the law forbids X to act, except at her peril; and let us ask calmly, whether such a law must not, so far, be a cause of collision?

Remark also, that this forbidding of X to act, except at her peril, is quite a modern innovation. Until special legislation took the matter in hand, X was distinctly cautioned that these cases existed, and though the onus of taking proper steps was thrown upon Y, X was told that she was bound to act also, if she had the slightest doubt about Y. Modern legislation has quite omitted to note that in all cases the ship which is furthest from the collision point has the greatest powers of avoiding collision. Seamen of old knew it, however, and distinctly provided for it, by making X *decline to act*, at her peril.

But supposing that X, in despite of present law, or in obedience to the old law, proposes to act. We have her, in Fig. 9 (p. 43), turning away from the danger, when it is at once plain that things, if not made worse, are not made better by this movement. The collision point is, in this particular case, moved a little further from Y, in space; but it is a law in turning that the speed over the arc is less than the speed on the straight course, and there might easily be no gain in time in moving the collision point to O'. Then, if we regard Figs. 7 and 8, we can see that if Y had turned either way, instead of continuing her course, the collision would have come about just the same. The collision

point is moved about, but it remains, and in no case does its removal exceed the limits which would be necessary to avoid a collision.

But if, on the contrary, X turns towards Y, as in Fig. 10 (p. 44), there immediately ceases to be any collision point; and if Y takes no steps whatever, yet shall there be no collision, even were X's turning powers considerably worse than they were. It is evident, in fact, that this turn will always be safe, unless the distance between the paths of X and Y is so small that there is not room for them to pass side by side; and unless also they both happen to be at this narrowest point at the same time.

We observe, then, that as regards the two ships X and Y, as we were first introduced to them in Fig. 3, there was, supposing them certain to come into collision at the point O, if they both proceeded, only one thing which could save it; that was, the turn of X towards Y, so as to get to parallel and opposite courses with her, and to pass her side by side. If we found a collision where this step had been taken, and where it turned out that there was not room to pass side by side, we might pronounce for "inevitable accident" so far, and look for a proximate cause in something which had brought the ships so near each other that nothing could save them. But, if on the other hand, we found that X had turned *from* Y, we should have a right to say that this turn was a cause of the collision, for we see by Fig. 9

Fig 7.

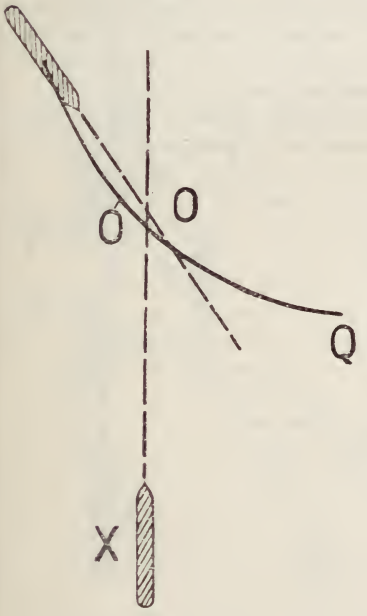
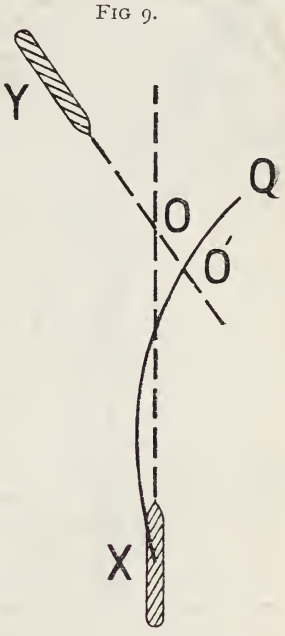


Fig. 8.



Fig 9.



that it could not stand for a moment in competition with the turn *towards* Y, as a measure of safety, while we could say this of it, that supposing Y, being nearer the collision point, had speed enough to pass it before X reached it, this turn of X's would tend to diminish that chance of safety, while the opposite turn on the part of X would tend to increase it. It would bring the collision point, if there was to be one, still nearer to Y, and give her a better chance of passing it before X came up. Otherwise, as in the case before us, it would remove the collision point altogether.

Enough has now been said to show that the turn *from* the danger must be held to be a cause of collision. It is an ultimate cause, either making a collision, or reversing the steps which would have avoided one already otherwise certain. For this we must hold modern legislation responsible, seeing that it reversed the old law. For the old law distinctly, and in terms, forbid it. It said this turn *from* the danger was never to be taken. It said to Y, when it put the onus on her in the first instance, "You must *invariably*, or *always*, turn towards the danger to avoid it."

There is no doubt but that the new law sprang up from a want of comprehension of the principles of the old one. The old one laid it down, by inference, plainly that ships should

seek to pass side by side, which was a safe method of passing, and to avoid crossing each other's path, which made it a mere question of time whether there were collision or no.

Modern legislation, in its various and unprincipled changes, has forgotten all this, and leads to insisting on one set of ships trying to get across the paths of other sets of ships. And why is it that there is so much more safety in passing side by side than in crossing? Simply because ships are so very much longer than they are broad. Few ships now are less than six times as long—taking outworks in sailing vessels—as they are broad; while many run to lengths ten times, or even eleven times, as long as they are broad. So that every movement which X or Y makes in turning *towards* each other, tends to reduce the risk of collision by reducing the target which each offers to the other; while every movement of either ship turning *from* each other tends to increase the danger, by increasing the target that each offers to the other.

Although this seeking of parallel courses was undoubtedly the old law, and although the facts are as I have stated them, and have not been controverted, yet an answer to the demand for the removal of this cause of collision by a return to the old principles, is given in the form of a *reductio ad absurdum*.

FIG. 10.

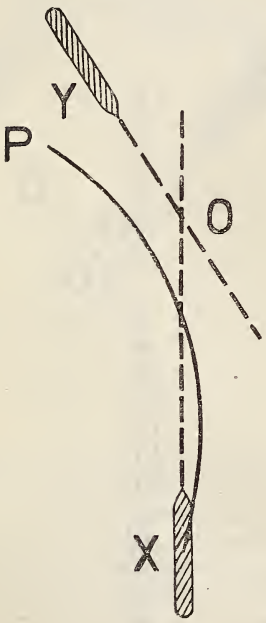


FIG. 11.

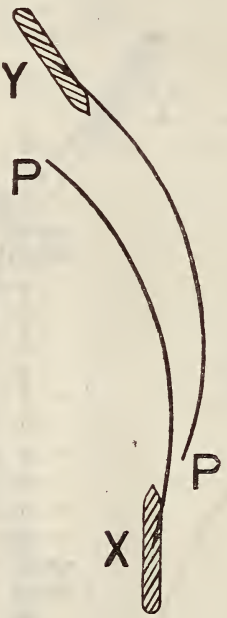


FIG. 12.



If, it is said, you encourage the seeking of parallel and opposite causes, you must encourage ships *to turn towards each other*, and then think of the danger!

One reply to this is given in Fig. 11, where X and Y do turn towards each other in this supposed dangerous way. It is seen that it is practically out of Y's power to strike X at all. X is what is called, in the language of naval tactics, "inside Y's circle;" or, as the French speak of it, "inside Y's dead circle," meaning on the water where Y cannot come by reason of her limited turning powers.

But those who use this attempt at a *reductio ad absurdum*, do not put the ships so close together. They put them afar off, as in Fig. 14 (p. 46), and very deliberately make them, after they have reached the safety position of parallel courses, contrive to turn—this time in defiance of their instructions—*from* one another, until they make a new collision point at O. Of course those who construct such a diagram have but a very faint notion of the principles they are dealing with, but I believe the fear of the collision at O has had a very material effect in preserving some causes of collision in the law.

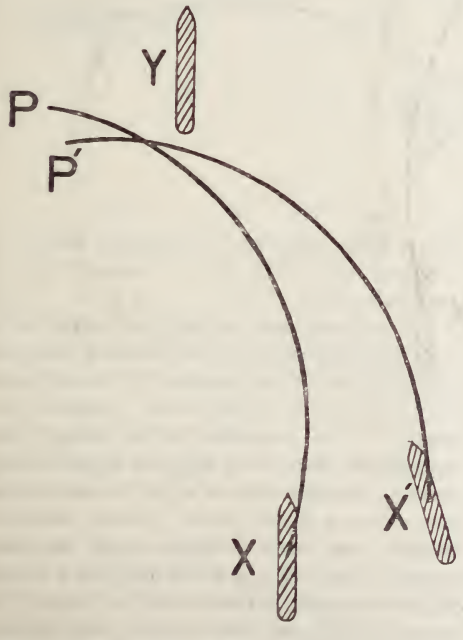
Collisions do sometimes happen, as shown in Fig. 14. But they happen so from precisely the same causes as would have produced them in Figs. 7 and 9, namely, in a want of knowledge of what is dangerous and what is safe;

in a belief that the turn *from* the danger is safe, and the turn *towards* it dangerous. I never knew a case of this kind where one or both ships had not had the most direct and clear warning to reverse the turn, or, at least, not to continue it. But as the very distinct signals which ships give to one another under such conditions have never been authoritatively interpreted, it is no wonder that they are disregarded.

But it is well, for a moment, to look at the other side, which is given us in Fig. 12. Here, according to what we know of the laws of turning ships, Y would beat Y^1 when her centre was exactly ahead of X's original position, supposing that she had turned *from* X; while she would be at Y^2, had she turned *towards* X. Y^1 almost, if not quite, frustrates X's endeavour to avoid a collision; while Y^2 very considerably increases the margin of safety which X had originally in turning towards Y.

The other *reductio ad absurdum* which is offered as an argument against a recurrence to the old principles, is illustrated in Fig. 13.

FIG. 13.



Suppose, it is said, that you advocated advising X to turn towards Y in any case of doubt, for it would come to this, we should have X coming up on the quarter or astern of Y, and imagining that Y was standing towards her, so as to cross her path, then X, in the position of X or X^1 would be encouraged to turn *towards* Y—a most dangerous proceeding. To this the rejoinder may be made, "Why dangerous?" Even if Y had no motion at all, neither X nor X^1 could touch her, with their helms hard over. But by the hypothesis Y has motion, more or less, and would be far distant from her present position by the time X or X^1 had completed the turn. But X^1 is in this position, that if she has greater speed than Y, which is part of the hypothesis, there is a collision point ahead of Y, at which a collision may occur. If X^1 is to go on her way, she must ultimately pass under the stern of Y, and so avoid the collision point altogether, or she may so increase her speed as to pass ahead of Y at a safe distance. There is, of course, no doubt whatever as to what is proper for X^1 in this case. She ought to turn towards Y, and pass under her stern, as it is a much quicker as well as a much safer proceeding. So then, the *reductio ad absurdum* turns out to be no such thing when fairly examined. In Fig. 13, X and X^1 are made to see Y at the same distance, and in the same direction, as X did in the former figures; and it turns out that whether X is mistaken or not, the turn towards Y is either harmless, or is the proper and seamanlike movement to make.

Thus we see, that we get two ultimate causes of collision—the neglect to turn towards the danger; and the turn from the danger.

Figs. 11 and 12 have shown us that there must be plenty of the ordinary cases where nothing but the turn towards each other can avoid the collision; and it may be stated as a general principle, that there can be no danger in this turn towards each other, unless their movements are simultaneous, unless the two ships are so equally distant in time and space from the collision point, and are so equal in turning powers, that the paths their centres describe are not further apart than the mean beam of the ships. Whereas, in any case of turning from the danger, there must be a margin of safety of the mean length of the ships, or else there will be collision. The proximate cause of many collisions is, therefore, the want of this knowledge.

I have already adverted to another proximate cause, namely, the law which forbids X to take early steps to avoid Y altogether, and which compels her, in spite of the distinct signal of danger which Y has exhibited, to stand on into it, without variation of course. The grounds on which this extraordinary and entirely modern order rests, are, that X would deceive Y by making any movement whatever.

This is is only to say, that any attempt of Y to seek a parallel course with X would be frustrated by any attempt of X to assist in it.

It may be admitted that, under the present confused law, there is a danger of this kind, but it is entirely artificial, arising out of the determination that one ship shall, in some way or other, cross the path of her neighbour, so that there is no legal place for the passage, side by side, on parallel courses. But, except for the law, this danger would not exist, and does not exist amongst boats, for instance, in crowded harbours at night. Here, without any laws at all, and without the advantages which coloured lights confer, boats habitually turn towards each other at all distances, and in a perfectly natural manner; avoiding collision with each other in the only way possible.

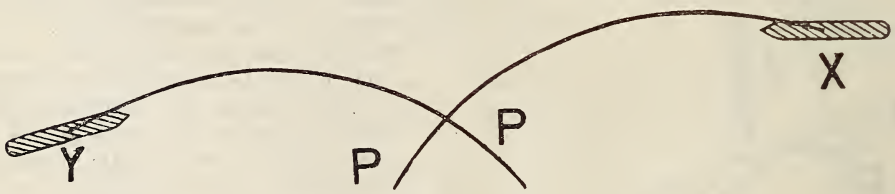
I might touch, for a moment, on the coloured lights which ships carry, and the perfect way in which they would act, if only the law were brought into harmony with them. But the law has grown in one way and the lights in another, so that there is not the harmony which could be wished.

In Fig. 14, and all the previous figures, the ships X and Y are by law directed to exhibit at night a red light, which shows over a considerable sector to the left of her path; and a green light, which shows over a considerable sector to the right of her path. In Fig. 14, X will see at first a green light only, while Y will see a red light only. Such signals clearly announce danger to each ship. But, by law, the same announcement is, to one of these ships, we will say to X, a positive order to stand on towards the collision point O, which the green light to her left has announced to be a-head of her.

Then the theory is, that X must stand on into the danger because any steps she might take would deceive Y. If X were to turn from Y, that might certainly be a deceiving movement, for there would be nothing to disclose it to Y. The red light was in sight before, and would be still in sight unchanged.

It is different with the turn towards Y, for

FIG. 14.



this very shortly shuts off the red and discloses the green light to Y—anouncing to her in plain terms, that parallel courses are reached; that there is complete safety, and nothing to be done but to proceed. So far from such a movement deceiving Y, it is one which would naturally, and in the absence of law, set his mind entirely at rest.

If the law forbids X to take any steps to avoid the danger which has been announced, it at the same time commmands Y to take the proper steps to avoid it. If Y inquires of authority what are the proper steps, authority replies "any, or all that are possible." The old law made a distinct answer; and would have said, "You must instantly avoid the path of the ship showing the red light. It is unsafe as long as it is to the right of your path; you must not lose a moment in bringing it on your left, by turning towards it."

The perplexity in which Y is thus left by the modern law must be a proximate cause of collision. If the red light is not a signal to make some particular movement, what is it a signal for? It is but a trumpet with an uncertain sound.

But, say those who uphold the contrary view, "If you *permitted* X to try to show his green light to Y, and if you *ordered* Y to show his red light to X, you would have absolute confusion." Yes, certainly, in the single case mentioned, where two ships of equal turning powers, of equal speeds, equal distance from the collision point, alter course simultaneously; you would certainly have confusion in such a case—if you could only get it at sea. As these equalities cannot all be obtained together, one signal must always take precedence of the other. The onus being on Y, X will not at first move, and the "red to red" of parallel courses will be established by Y's movement alone. But if from causes, Y delays, X seeking her own safety, shows Y her green light. Then parallel courses are reached through "green to green," and all goes well.

But it may be that while X is turning, he sees

Y's green change to red. This is only a distinct signal to X either to discontinue turning, or to turn back again to his old course. Or if Y, while turning, should see X's red light change to green, this is to her but a distinct signal to discontinue turning, or to turn back to her old course, parallel courses having been reached, and he being duly apprised of the fact by signal.

You will search almost in vain through the records of collision for cases where X and Y have so obeyed the signals made by the lights. You will have no trouble at all in finding cases where collision followed direct disobedience to them. Thus, you will often find a Y turning gradually with small helm, towards an X, as in Fig. 14; then seeing X's red light change to green, putting her helm hard over, so as to make certain of finding a collision point at O. But after such a display of determination to get into collision somehow, you will not find any authority, legal or other, to censure her. The lights are there—excellent in many ways—they are intended as guides to ships, but are steadily ignored as such, and the simple but very plain signals they convey are not allowed to be acted on in some cases; in others disobedience to them is not censured.

Such appear to be some of the chief causes of collision. There are several proximate causes which may be glanced at before I close this paper.

A prolific cause is the wide-spread use of the white light. A white light seen at sea may now denote (1) A steamer; (2) A ship at anchor; (3) A vessel's stern light; (4) A pilot vessel; (5) An ordinary light on shore. The proximate causes of collision, the drawing of ships together by false signals, can frequently be traced to this curious forgetfulness of the authorities that a white light is a white light and nothing more, and that out of four or five meanings given to the same appearance, it is not always easy to hit by guesswork on the right one.

No doubt a "bad look out" is often a proximate cause of collision, but it is very rare to find a bad look out followed by a proper movement, and an ensuing collision. The dangers of a bad look out are clearly remediable in most collisions by a proper movement. No doubt, neglect to show the proper light is a cause of collision. But the neglect is not always a moral obliquity. It is remarkable how often the accusation lies against the sailing ships inclined by the wind, and how seldom against the upright steamer. Put the facts together, that it is usual to have plano-convex lenses before the lights, and that there are no "gimbals" as a rule, and we can discount a good deal of the neglect.

A palpable cause of collision is the way in which the rules of the road overlap each other, so that it cannot be said where one ends and another begins.

It is an obligation to turn to the right in some cases, and when it is, it lies equally on both ships. But the limits of the order are indistinct, and we find one ship obeying it and the other disobeying it, each with an equally clear conscience, and so making collision.

There is one set of rules for ships which are "crossing," which are overridden by another set of rules when a ship is "overtaking" another. "Overtaking" has grown to be defined as "having the greater speed," and different judges have differently interpreted the term, so that there is a considerable sector surrounding every ship, on which, if you approach, you will have a legal right to act on one set of rules, while your neighbour will have an equal right to act on another set of rules.

Then, on the whole, one of the causes of collision which is apparent in the modern rules, when compared with the ancient, is the fact that modern rules form a body of compulsions and rights to be insisted on; while ancient rules formed a body of mutual concessions, fit to be acted on for the convenience and safety of sea traffic.

DISCUSSION.

Mr. Francis Cobb said they were deeply indebted to Captain Colomb for bringing forward this important subject, which was worthy of the deepest consideration. Per-centages had been given of the various causes of collisions, but he thought they might all be condensed into one item, viz., want of a good look-out, for that was a proximate cause of most collisions. In these days of competition, trading steamers, especially for short voyages, were often under-manned. A steamer left port with a crew who had been at work all day; the engineer had got up steam whilst the last of the cargo was being got in, and she left, with a tired crew to keep a good look-out for incoming steamers. Captain Colomb had gone scientifically into the causes of collision, which he had exemplified by the diagrams; but he thought he had been rather hard on the Board of Trade. He said the rules were that a captain was to do a certain thing, unless it was his duty to do something else; but he (Mr. Cobb) rather thought the rules were to the effect that the captain must obey the rule of the road, and if he thought proper to depart from it,

and do something else which he thought better, he must be prepared to justify his conduct if a collision resulted. Looking at Fig. 8, it would be found that the starboard light of Y was visible to X, which would be a green light; and the old rule, and, he believed, the present rule, was that X should starboard his helm; this would bring him into the position shown in Fig. 11. But it was not sufficient for X to starboard; Y had the port light of X visible in that position, and Y's duty was to keep on her course until some change took place. Passing to Fig. 14, where the ships were supposed to be in the same position as in Fig. 8, he could hardly suppose that they were so. In that figure the lights would be pretty nearly end on, and therefore X would see the three lights of Y, and know that she was coming nearly end on, and that a collision was inevitable unless something were done. Fig. 11, no doubt, showed clearly what ought to be done, but it was exactly what the old rule of the road provided; and he was not aware that the Board of Trade had altered it, except to give the latitude he had before referred to. Captain Colomb had shown what would happen if a man followed his natural instinct, to try to get away from a danger; a collision was made inevitable, but doing so would be in direct contravention to the well-recognised rule that where you saw a green light, your duty was to starboard your helm, and get out of the way; but where you saw a port light clear, you might keep on. The diagrams would lead one to suppose that they were dealing, to a great extent, with steamers, because a sailing ship could not go right or left, just as was supposed; and the rule was, that a steamer must get out of the way of a sailing ship. Taking Y to represent the sailing ship, and X the steamer, the latter could easily get out of the way. The gentlemen at the head of the Board of Trade had given this matter very weighty and lengthy consideration, and had not amended these rules in any arbitrary or capricious spirit, or without taking the best advice obtainable. No doubt conditions were continually changing; Captain Colomb had shown how difficult it was for a steamer, whose length was eleven times her beam, to come round the circle as the *Thunderer* did, and with these alterations in navigation, certain additions must be made to the rules of the road. Notwithstanding the objections he had offered, he felt, personally, under great obligation to Captain Colomb for bringing the subject forward. Setting aside the loss of property, the loss of life by collision was most grievous; but in the case alluded to, of the *Princess Alice*, had the ordinary rules of the road been adhered to, the unfortunate steamer would never have attempted to cross the bows of the other ship as she did, and the calamity would have been avoided.

Mr. LIGGINS said there could be no doubt of the importance of this question, for everyone's life, when at sea, depended on the various rules of the road being strictly observed. In that day's *Times*, four serious collisions were reported, not one of which was analagous to the cases now brought forward. It was not an easy thing to alter the rules of the road, which had been framed by England, as the greatest maritime power in the world, and adopted by other nations. Steam had introduced a certain number of modifications, but these had been well considered by those best fitted to judge —the Lords of the Admiralty, the Elder Brethren of the Trinity House, and of late years by the nautical assessors at the Board of Trade. It seemed to him an extraordinary assertion to make, that a set of rules which were faulty and dangerous had been given by these authorities. He had expressed the same opinion some years ago, when Captain Colomb read a similar paper before the Royal United Service Institution. These rules could not be interfered with without serious danger, seeing that all trading nations had adopted them, and would have to be consulted before a change was made. It was about forty years since the Admiralty substituted the word "port" for "larboard," so that it should not clash with "starboard," and he saw it announced only last week that the French had introduced the same improvement. He denied that any of the cases shown in the diagrams could, or ought to occur. He held in his hand a small sheet of paper, containing twenty-six rules, the last of which was only applicable to ornamental sailing in a fleet. They were, therefore, not very numerous, they were perfectly simple, and were familiar to every nautical man. Captain Colomb had not told them that there were rules for steamers, for sailing vessels, and for steamers and sailing vessels meeting; and, with regard to these diagrams, they were not told whether they represented steamers or sailing vessels. Assuming them to be sailing ships, and that, in Fig. 3, the vessel marked in the diagram X was a ship running before the wind, Y could not be, and in that case the rule of the road provided that X must get out of the way. And how must she do it? Any one crossing the Strand would not go right in front of a brougham with a pair of horses, but astern of it, and so with the ship in the diagram; she would not port her helm and run under Y's bows, but starboard. The rule would be different for steamers. The only accidents he had seen with yachts had been where one man had been obstinate, and the one on the port tack would not give way to the one on the starboard tack. Serious accidents sometimes occurred in that way, but the law compelled the man who did the injury to pay for it. He did not agree that there was so much difficulty in getting a fair and right decision as to collisions. On the 23rd of last month, he crossed the Channel in a heavy gale of wind, very near the spot where a collision occurred between a steamer and a large sailing vessel. That case was tried in the Admiralty Court, and a very just decision given. It appeared that the sailing vessel was shifting her lights, and so prevented the steamer seeing her, and therefore the steamboat was exonerated. If the lights had been visible, it would

have been otherwise, for then the steamer must have got out of her way. Two collisions were reported in that day's *Times*, neither of which were dependent on any such rule as Captain Colomb would like to alter. The rules were found to work well, and were admirably simple, so much so, that people thought it safer at night than by day, because there were not so many sail about. In Fig. 14, he contended that both ships were breaking the rule, and if they adhered to it, they would go clear of each other.

Rear-Admiral MORESBY thought the remarks of the last speaker had gone far to confirm Captain Colomb's views. At the same time, he thought the Captain had forgotten that the rule of the road at present was calculated on the distance at which ships first saw each other, which was supposed to be two miles, at which distance there was time for the rule of the road to be acted upon. Looking at it in that view, there must be great danger in altering the existing rules. It certainly was true that the captain of X (in Fig. 3) had the liberty, under a very serious responsibility, of obeying the law which Captain Colomb had shown, mathematically, was the only safe rule to escape a collision. They could not get out of the fact that there must be a collision if the two ships turned from each other, whilst if they turned towards each other they would avoid it. But this was only mathematically correct when they came within the arc of the circle; it was not correct before they reached that point. Therefore, he thought the present rule of the road—which could not, more than any other human law, provide for every contingency—provided for most contingencies. From the cases of collision on which he had sat as assessor, and from many others which he had read, he had come to the conclusion, that many of these accidents simply arose from the feeling on the part of a half-educated man in charge of the deck, that the vessel he was near to would get out of his way; he, being obstinate, would not get out of the way, and the other man, knowing he was on the right tack, did not get out of the way either. It should not be lost sight of, as Mr. Cobb had stated, that ships being under-manned, and the want of a good look-out was, in many cases, the primary cause of collisions.

Mr. DIPNALL said it might appear somewhat impertinent in a landsman to say anything on this subject, but at the same time, seeing there were as many landsmen at sea as seamen, and perhaps more in the summer time, he thought they had a right to examine it from a landsman's point of view. Having given a number of figures, showing the number of vessels, tonnage, and crews of English ships, and number of wrecks, and loss of life, and the loss of property at sea (amounting to four millions a week), he said he thought the words used by Admiral Moresby—"half-educated," was the key to the whole question.

Rear-Admiral MORESBY said he did not mean to convey that captains of ships were half-educated.

Mr. DIPNALL said he referred to the men who were in charge when danger was at hand. Referring to the collision last Christmas, off Cork harbour, between the Cunard liner *Catalonia*, and a sailing ship, the *Helensee*, he said there was a good deal of conflicting evidence in the case on some points, but ultimately the blame was thrown, by the stipendiary magistrate, on the sailing vessel, because, though there was a pilot on board, the captain gave the order to starboard, which brought her across the *Calalonia's* bows. He regarded this matter as one in which education had yet a great deal to do. They wanted more schools of navigation, where the art should be taught practically.

Captain HEATHORN asked if the diagrams 4 and 5 indicated the vessel's power of steering according to their velocities; and whether the difference of momentum should not be thought more of than the mere fact of getting out of the way. It occurred to him that something might be done by devising a means for checking a vessel's way, and stopping her.

Mr. JOHN GLOVER, as a shipowner, said some comfort might be derived from the fact that collisions at sea had been steadily decreasing. It was only fair to the rules, and to the gentlemen who had so much to do in administering them, to bear in mind that, in spite of the greatly increased traffic, collisions were fewer than formerly. He often heard from captains and seafaring people what they thought would be one improvement in the rules, and which would greatly diminish the chance of collision, viz., if something were done by which a change of helm could be reported to the ship in sight, some signal by which those on board one ship could know the manœuvre which the other had determined on. Although the rules were very good, he felt persuaded that they caused a great many collisions, anomalous as that statement might appear; and they did so by inducing officers of ships to allow their vessels to get too near to other ships, which, but for reliance on the rules, they would keep clear of. It was their close proximity which was the main cause of collisions. He did not know whether the Board of Trade could do anything to discourage so much reliance on the rules, and to teach everybody to rely more on giving other ships a wide berth; but shipowners could not do it, for this reason. When a collision occurred, their mouths were shut; they might have a strong opinion that their officers were in the wrong, but, because of the money damages they might be called upon to pay for faults which they did not commit, and had no power to prevent, they were obliged to screen their servants, even if they thought they were in the wrong. That was the result of introducing the doctrine of master and servant into a relationship where it had no business; the shipowner,

who generally knew most about it, was made a strongly interested party in concealing the truth.

Mr. LIGGINS said that article 19 of the rules provided for steamers making known their change of helm.

The discussion was adjourned until Friday, at eight o'clock.

Miscellaneous.

ECONOMIC PLANTS IN INDIA.

Dr. King's annual report on the Botanic Garden, Calcutta, to July last, contains, perhaps, less information on economic plants than usual. He, nevertheless, has something to say on the all important subjects—india-rubber and paper materials. Under the first head he reports that the Ceara rubber (*Manihot glaziovii*) continues to grow well. The trees, at the time the report was written, were beginning to seed, and from their produce Dr. King was able to distribute, during the year, a good many seedlings to tea planters in Assam, Cluttagong, and elsewhere. A species of *Landolphia*, which is one of the sources of the rubber collected in Eastern Africa, has (thanks to the exertions of Sir John Kirk, her Majesty's Consul-General at Zanzibar) been introduced to the Garden. From the seeds sent by Sir John Kirk, a number of young plants have been raised, and these at present look very healthy. The cultivation of the plant yielding Para rubber (*Hevea brasiliensis*) has been abandoned, as the Bengal climate proves quite unsuitable for it. Of *Castilloa*, another South-American rubber yielder, there were, in the Calcutta Gardens, at the time the report was written, only eight plants, but it is being propagated as fast as possible.

On the subject of materials for paper, Dr. King says that the utilisation of plantain fibre as a raw material for paper-making has engaged attention during the year. It has been found that, during the dry months, simple exposure of the sliced stem to the sun is sufficient to prepare the fibre for the paper-making, provided the paper-mill be on the spot. What is still wanted, is some cheap mode of removing the useless cellular tissue, so that the fibre may be shipped to England without the risk of fermentation during the voyage. The cultivation of the plantain for its fruit is so universal over the warmer and damper parts of India, and its growth is so rapid, that the conversion into a marketable commodity of the stem—at present thrown away as useless—would be an appreciable addition to the wealth of the country. The matter is, therefore, one deserving of attention. Another fibre-yielding plant that merits attention is the paper mulberry of China and Japan (*Broussonetia papyrifera*). The bark of this tree yields one of the best paper fibres known, and it is naturally so white that it requires very little bleaching. Having procured seeds of this plant from Burmah (in some parts of which province it grows wild), and from seedsmen in Europe, the cultivation is now being tried in the Calcutta Garden, and at the Cinchona plantation in Sikkim. A plant known in the North-West Provinces as *bhabur ghas*, and botanically as *Eriophorum comosum*, has been before reported upon by Dr. King as a hopeful paper material, but the cost of carriage from the North-West Provinces precluded the idea of its ever being exported as such to Europe. Leaves of a plant, which are very like those of *Eriophorum*, were found last cold season growing rather abundantly in the dry forests of Chota Nagpore by Mr. Gamble, Conservator of Forests. Mr. Gamble, at Dr. King's request, supplied him with some hundredweights of these leaves; they were made over to the Baley Paper Mills Company for trial, and they were most favourably reported upon. The leaves were collected during the cold season, and no flowers could then be found by which the plant could be botanically identified with certainty. As Chota Nagpore is so much nearer Calcutta than the North-West Provinces, it is probable that the conveyance of these leaves to Calcutta may not be so costly as to prohibit their export to Europe, as a raw material for paper fibre. It still remains to be learnt, what quantity the Chota Nagpore forests are likely to be able to yield; and the quantity available is rather an important point in determining the feasibility of introducing a new fibre to the market, as a raw material for paper. *Eriophorum* is not very far behind esparto in its yield of dry fibre, while the fibre yielded is about equal to that of esparto in strength.

KOLA-NUT TREE.

In continuation of the note printed in this *Journal* (xxx, 624), the following extract from a paper printed by Mr. T. Christy, is now added :—

"I introduced the kola nut (*Sterculia acuminata*) into England, about eight years since, and it has lately been subjected to European analysis. It has been found to contain the same active principle, viz., caffeine, and more of it than the best coffee, and to contain also the same active principle as cocoa, but less fatty matter. Possessing the same qualities as these favourite beverages, it only needs proper treatment to develop a special flavour, and it would then probably be able to compete successfully with those beverages. The nuts are used to form a refreshing and invigorating drink throughout a large portion of tropical Africa, their use being said to support the strength, allay inordinate appetite, assuage thirst, and promote digestion, and to render those using them capable of prolonged fatigue. The negroes prefer them to tea or coffee, and when they can obtain kola nuts, will not touch coffee. Dr. Daniell says of them :—'It would be difficult to find any product

which constitutes such an important article of commerce in Soudan as the kola nut.' Wherever the negro has been transplanted to a foreign country, he has taken the kola nut with him. I have recently been informed by Mr. Espeut, a well-known sugar planter of Jamaica, that the negroes use the kola nut as a remedy for drunkenness; that swallowing a single nut, ground up and made into a cream or paste with water or spirit, no sign of intoxication remains half-an-hour afterwards. Confirmatory evidence of this property in the kola nut is given by a surgeon, Mr. Papefio, who tells me that alcoholic drinks do not produce intoxicating effects, when the kola nut is eaten at the same time. It appears, therefore, that the craving for drink, which is a strong incentive to drunkenness, may be subdued by the use of this valuable stimulant and tonic, as, after chewing kola nut, great disinclination is felt to all forms of alcohol. It has also been found to possess a beneficial action on the liver, its continual use preventing attacks of despondency, to which negroes are peculiarly liable. Dr. Daniell records a case of this kind, in which the kola nut put a stop to an epidemic of suicidal mania, which threatened at one time to depopulate the estate on which it occurred. It is also used by the natives when in a low state of health, and suffering from the skin cracking and peeling on the hands and feet.

Notes on Books.

THE LAND OF THE WHITE ELEPHANT. By Frank Vincent. New York: Harper Bros. 1882.

This is the second American edition, or the third in all, of Mr. Vincent's book. It gives an account of the author's travels to Burma, Siam, Cambodia, and Cochin-China. Mr. Vincent gives a long and careful account of the extraordinary ruins of Angkor, about the origin of which scarcely anything seems to be known by the people of the country.

JAPAN: ITS ARCHITECTURE, ART, AND ART MANUFACTURES. By Christopher Dresser, Ph.D. London: Longman, Green and Co. 1882.

In February, 1878, Dr. Dresser, who had just then returned from Japan, read a paper before the Society on the art-manufactures of that country. He has now produced a book, which is the result of the same journey. The book is divided into two parts. The first part gives an account of Dr. Dresser's travels in the country, and his experiences of the manners and customs of the natives. The second part describes the architecture, manufactures, and arts of Japan. Dr. Dresser seems to have enjoyed unusual facilities for investigating the industries of the country, and the methods of manufacture adopted by the natives. He devotes a considerable portion of his book to a description of the methods employed by native artists in producing their rapid sketches, and the chapter in which this is described is illustrated with a large number of *facsimiles* of Japanese drawings. The book is handsomely got up, with thick paper, and possesses a somewhat remarkable cover of canvas, embellished with Japanese designs. It is to be feared that this material is too likely to catch dust and dirt to make it very suitable for book-binding purposes.

Obituary.

RIGHT HON. SIR WILLIAM HUTT, K.C.B.—Sir William Hutt, who died last week, at the age of seventy-nine, was elected a member of the Society of Arts as far back as the year 1853, and for several years he held the office of Vice-President. He was M.P. for Hull from 1832 to 1841; and for Gateshead from 1841, to January, 1874; he filled the office of Vice-President of the Board of Trade from 1860 to 1865, and in the latter year was appointed to negociate a commercial treaty at Vienna.

DAVID GORDON LAING.—By the death of Mr. Laing, the Society of Arts loses one of its oldest members. He was elected in 1831, and has since that time been a frequent attendant at the meetings. At the last occasion of his being present, he spoke in the discussion which followed Mr. Comyns Carr's paper on Barry, and he then expressed the interest he felt in the history of pictures which adorn the Society's meeting-room.

General Notes.

LACE AND FAN EXHIBITION AT BRUSSELS.—The section of technical instruction of the Brussels Chambre Syndicate has adopted the report of the competitions committee, appointed last June. This engages the section to organise an exhibition of lace, which will include (1) the ancient productions of Belgium and other countries, and (2) modern lace and designs exclusively Belgian. There is also to be a competition for a lace design, and for a fan with design of the frame.

MEETINGS OF THE SOCIETY.

Friday evening at Eight o'clock:—

DECEMBER 1.—Adjourned discussion on CAPTAIN COLOMB'S paper, on "Collisions at Sea."

Wednesday evenings at Eight o'clock:—

DECEMBER 6.—"The Artificial Drying of Crops." By WILLIAM A. GIBBS.

DECEMBER 13.—"Electrical Exhibitions." By W. H. PREECE, F.R.S.

DECEMBER 20.—"The Utilisation of Waste. A Quarter of a Century's Progress." By P. L. SIMMONDS.

For meetings after Christmas :—

"Some Points in the Practice of the American Patent Office." By Sir FREDERICK BRAMWELL, F.R.S.

"The Sanitary Inspection of Houses." By W. K. BURTON.

"The Modern Lathe." By J. H. EVANS.

"The History of the Pianoforte." By A. J. HIPKINS.

"Technical Aspects of Lignification." By C. F. CROSS, F.C.S.

"Self-purification of River Waters." By W. N. HARTLEY, F.R.S.E.

"The Application of Electrolysis to Bleaching and Printing." By JAMES J. DOBBIE, D.Sc., and JOHN HUTCHINSON.

"The Formation of Diastase from Grain by Moulds." By R. W. ATKINSON, B.Sc.

"Recent Improvements in Agricultural Machinery." By D. PIDGEON.

"English and Foreign Silver Work; with some Remarks on Hall Marking and its Advantages." By WILFRED CRIPPS, F.S.A.

"Overland Commercial Communication between India and China, *viâ* Assam." By CHARLES H. TEPPER.

"Agriculture in Lower Bengal; with a notice of Tenant Right, &c." By W. S. SETON-KARR.

"Private Enterprise in India." By J. M. MACLEAN.

"Some Notes on the Domestic Architecture of India." By C. PURDON CLARKE.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Silvanus Thompson, "Dynamo-Electric Machinery." (Lecture I.)

Farmers' Club, Inns of Court Hotel, Holborn, W.C., 6 p.m. Adjourned discussion on "Farm Tenancies."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. W. Martin, "The Strength of Boiler Flues."

Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on "The Ordnance Maps, and Suggestions for their Improvement."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. R. P. Pullan, "The Decoration of St. Paul's Cathedral."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Rev. O. D. Miller, "Assyrian Inscriptions."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. John Ruskin, "Crystallography."

TUESDAY, DEC. 5...Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Annual General Meeting.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on the paper by the late Mr. Robert Briggs, "American Practice in Heating Buildings by Steam." 2. Mr. John Daglish, "The Sinking of Two Shafts at Marsden for the Whitburn Coal Company."

Pathological, 53, Berners-st., Oxford-st., W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m.

WEDNESDAY, Dec. 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. A. Gibbs, "The Artificial Drying of Crops."

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m. Council Meeting. 1 p.m. Annual Meeting of the Central Chambers.

Geological, Burlington-house, W., 8 p.m.

Entomological, 11, Chandos-street, W. 7 p.m.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Mr. W. A. Shenstone, "The Crystalline Constituents of Jafferabad Aloes." 2. Mr. E. U. Holmes, "The Sale by Public Auction of Spurious and Worthless Drugs."

Archæological Association, 32, Sackville-st, W., 8 p.m.

Obstetrical, 53, Berners-street, Oxford-st., W., 8 p.m.

THURSDAY, Dec. 7...Archæological Institution, 16, New Burlington-street, W., 4 p.m.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. J. G. Otto Tepper, "Tasmanian Plants in South Australia." 2. Mr. G. Brook, "New and Little Known Collembola." 3. Dr. Nylander and Rev. J. M. Crombie, "Lichens collected by Dr. Maingay in Eastern Asia." 4. Mr. W. F. Kirby, "The Genera and Species of Chalcidinæ."

Chemical, Burlington-house, W., 8 p.m. Ballot for the election of Fellows. 1. Messrs. F. R. Japp and F. W. Streatfield, "The Condensation Product of Phenanthraquinone with Ethylic Acetoacetate." 2. Mr. W. H. Perkin, junr., "The Condensation Products of Venanthol" (Part I.) 3. Mr. W. H. Perkin, jun., "The Condensation Products of Isobutylaldehyde obtained by means of Alcoholic Potash." 4. Dr. H. E. Armstrong, "The Formula of Lophin." 5. Mr. S. U. Pickering, "The Molecular Weight of Basic Ferric Sulphate." 6. Mr. S. Dyson, "Certain Brominated Compounds obtained in the Manufacture of Bromine." 7. Mr. F. Woodland Toms, "The Chemistry of Hay and Ensilage." 8. Mr. W. H. Perkin, "Note on the Preparation of Diphenyleneketone Oxide."

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. Ernest Pauer, "Beethoven's Earlier Sonatas."

South London Photographic (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m.

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Opening Address by the President, Mr. R. Harkness Twigg.

Society of Engineers, 6, Westminster-chambers, W., 7½ p.m. S. Mr. Henry Adams, "Strains on Ironwork." (Lecture I.)

FRIDAY, DEC. 8...Froebel Society (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Annual Meeting.

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, DEC. 9...Physical, Science Schools, South Kensington, S.W., 3 p.m.

Boyal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

CORRECTION.—P. 22, col. 1, line 9 should come after line 10, and the passage will then read :—"Of this, 1,800 kilogrammes has formed into ice, and 360 kilogrammes has evaporated, and either passed through the pump, or to the acid."

Journal of the Society of Arts.

No. 1,568. Vol. XXX.

FRIDAY, DECEMBER 8, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The first Lecture of the First Course of Cantor Lectures, on "Dynamo-Electric Machinery," was delivered by Professor Silvanus P. Thompson, D.Sc., on Monday evening, the 4th inst. The subject of the lecture was the dynamo in theory.

FOREIGN AND COLONIAL SECTION.

A meeting of the Committee of this Section was held on Wednesday, 6th inst., at 4.30 p.m. Mr. Hyde Clarke in the chair. The Secretary submitted a list of the offers of papers for reading during the present Session, which was discussed and agreed to. Particulars will be announced in due course.

Proceedings of the Society.

EXTRA MEETING.

The discussion on Captain Colomb's paper on "Collisions at Sea," was resumed on Friday evening, December 1, Sir Frederick Bramwell, F.R.S., in the chair.

Captain Colomb opened the discussion by reading a *résumé* of the main points of his paper.

Captain Parfitt said Captain Colomb had exhibited a number of diagrams, which were extremely interesting, not only as showing the particular points at which collisions occurred, but more so, as showing the turning power of ships. But though these diagrams were conclusive on these points, they did not appear to him to be conclusive as showing the causes of collision, except at the particular poin shown on the diagrams. Taking Fig. 11, instance, no doubt it showed distinctly what Captain Colomb wanted to prove, that if two ships put their helms over, and turned to each other, or towards the danger, they would, if in those particular positions, avoid one another. But if the position of Y were altered a little, if, for instance, she were put on the top of letter Y in the diagram, and the same curve were then drawn, it would be found that the two curves would cross, and the ships, if they followed the course recommended, would inevitably come into collision. It had been said that figures would prove anything, and he was inclined to think the same thing might be said of diagrams. Again, Captain Colomb said, that in the course of this proceeding towards each other, a time would arrive when one or both would, by the change of lights, see that it was either his duty to continue the helm under which he was, or to shift his helm and go the other way. Now, he had had a considerable experience of collisions—not in his own case, happily—and he had come to the conclusion that if the vessels proceeded on the course as shown in the diagram 6, it took a considerable time, even after the helm was hard-over, for them to deflect much from the course. If they then went on and saw the two lights of the other vessel, they would be almost in the agony of a collision, and he need not point out how difficult it would be for a ship with her helm hard-a-port to immediately shift it over to hard-a-starboard. If it were difficult for her with her helm amidships to make a considerable detour, by putting her helm hard-over, it would be much more difficult to do so when her helm was hard-over the other way. Having thus criticised the paper to some extent, he was very glad to say there were many points on which he thoroughly agreed with it. There was no doubt, that when a vessel saw a light, it simply showed the direction in which the other vessel was; it conveyed no information as to either her course or the speed at which she was going, both points of greater importance than the mere direction in which she bore. It might be difficult to alter the present lights, seeing, as had been already said, they had been adopted by other nations; still, there had been alterations in the rules, which had been adopted by other nations. If lights could be so placed that one vessel could see another, and tell as well by night as by day what course she was steering, and the speed she was going, it would prevent many accidents. He did not hesitate to say that this was quite possible, and it was not a new idea, having been propounded soon after the present lights were instituted. When he was in the Red Sea in 1849, they carried side lights before they were introduced by law, the only differ-

ence being, that the port-light was green and the starboard red. The Government only transposed the lights.

The CHAIRMAN remarked that there was a reason for the change; anyone could recollect red-port.

Captain PARFITT said that even in those days he could see the weak points of the lights. They did not want to know the width of a ship, but her length. If the lights were so arranged as to show the length, in the same way as it was shown in the daytime, by the foremast and mizenmast, they could tell, by the way the lights opened and shut, the course the ship was steering, and her speed. The present light was simply a light, and nothing more. A ship might see a red light on her starboard bow, and she could not tell whether it belonged to a slow ship going at right angles, or to a very fast ship coming down on her at three or four points from her course. Lights were thus one cause of collisions, and the question was how were they to make the best of them until the happy day came when a better system was introduced. The great difficulty was with steamers crossing, and Article 16 was the only one which really applied to that case. That required the vessel having the other on her starboard side to get out of the way, with the supplement of the succeeding article, that the other vessel should continue on her course. That had always seemed to him to want a little addition, and Captain Colomb had shown how proceeding on the course often entailed a great amount of danger. If some addition were made, throwing on the other vessel the duty of doing something to help in getting out of the way, he believed there would be a great lessening of collisions. Again, there were, in the rules, some words which he had always looked upon as extraordinary, viz., the words, "involving the risk of a collision." Was it to be left to the master of the ship to decide whether the risk of a collision was involved. Again, there was another rider to the 23rd and 24th Articles that nothing should exonerate the master if he did not do something, such as the special circumstances of the case required. Notwithstanding there were certain rules laid down for his guidance, if the special circumstances of the case required it, he was to disobey them. He called that a cruel mockery; it required the master of a ship to be omniscient. The words might be very well as a saving clause from a lawyer's point of view, but they were not much use to a sailor. Mr. Glover had said one thing which was very much to the point, namely, that leaving out all question of rules, his general orders to his officers were to give everything a wide berth. The rules said that when one vessel did so-and-so, the other vessel should keep her course; but they did not lay down as they ought to, that the vessel that had to get out of the way should, at the earliest possible moment, show the other vessel what she was going to do. He had been on vessels as a passenger with some of the smartest pilots in the Channel, and had seen those men when they saw a vessel crossing—the crossing vessel being bound to keep her course—go on so long without shifting the helm, that he could only say it was enough to put the man in charge of the crossing ship in a fright; and if he had to decide in a case of that sort, where a collision occurred, he would have exonerated that man if he moved his helm. It was true the pilot had faith in his vessel, and when he got within a ship's length or so, he moved his helm and went under the stern of the other, but he did not see why the movement should be left to the last minute. If it was one man's duty to get out of the way, it should also be his duty to let the other vessel see as soon as possible that he was going to do so. Something had been said the other night about half-educated officers, and he was sorry to say, from his experience, that he feared there was an immense amount of truth in that. There were a number of half-educated officers, and the only marvel to him was how some of those who had come before him had obtained their certificates. He could only attribute it either to cramming or to a very lax examination, but he was told that the examination, so far from being lax, was extremely severe. All he could say was, if such was the case, it was a marvel to him that many whom he had had before him, and known not to possess the very rudiments of practical navigation, had been able to pass and get such certificates.

Mr. PARKER RHODES said, as a landsman, he should not attempt to criticise the diagrams, but he must say, and that they seemed to illustrate some very fine points in navigation, and that from them a mere novice got a great deal of information. Captain Colomb's paper really pointed to the result of imperfect examination, the result being the loss of ships. It was not only the way in which a ship must be steered by the rules of the Board of Trade, but much depended on the qualifications of the man at the helm. Now, in the merchant service—happily it was not so in the Royal Navy—there were a great number of foreigners. In the course of his official duties, when connected with the Consular service, he had had from 30,000 to 35,000 seaman passing through his hands, and had noticed that the majority who presented themselves, even for over sea voyages, were foreigners, and, in many cases, he had had to explain to them, either in French or Italian, what their duties and their rights were. It was painful to notice the miscarriage of justice, the wrongs that were committed on all sides towards the men, towards the ships, and towards the owners, through this system. To that he should attribute nine-tenths of the cases of collisions. He had recently read an account from an officer in the merchant service, of a collision in which he was concerned, where the man at the helm, being a foreigner, completely misunderstood the order given him, and put the helm in the opposite direction to what was intended. The two ships came side by side, and fortunately, only a little damage

was done; but another foreigner, who was on the look out at the bows, also misunderstood the order which had been given to him, and fell overboard in attempting to carry it out. He did not agree with Captain Parfitt as to seamen not being well educated. There was no possibility of cramming common individuals; you might cram young gentlemen with particular subjects, but you could not cram an ordinary man; and, in his opinion, the reason these men appeared in such an unfavourable light to Captain Parfitt, was the strange position in which they appeared before his tribunal. When the Merchant Shipping Act was amended, he strongly urged on the Department that a certain number of Consular officers, merchant captains, and shipowners should be appointed to revise the Act, so that it might suit all parties. Other countries had adopted our system, and if the laws were altered, we should have to go to them and get their consent, which would take some time. With regard to steamers and sailing vessels, there was no doubt the steamer ought to be responsible for getting out of the way. It was simply the case of a Hansom cab and a heavily laden wagon on a road. The Hansom cab should be made to get out of the way, even if it was in its right position, because it was so much more easily handled. The handling of the ship depended entirely on the power the rudder had over the hull; and it had occurred to him for many years that the rudders, in general, were very faulty, and quite incapable of doing the work required of them. He had suggested to some of his nautical friends a plan which he experimented upon with a boat, and that had answered very well, namely, that the rudder should have two wings at the end, so that it spread out when the helm was put in motion, and added greatly to the steering power, and prevented any dead water.

The CHAIRMAN said Captain Colomb had shown that collisions must have necessarily many causes, and no doubt it was so. One cause which he suggested was the rules of the Board of Trade, which might be improved, and the primary object of the discussion was to see whether that was so or not. It must be remembered that at the present time, when a fifteen-knot speed was by no means uncommon on certain lines, if two ships saw each other, a mile apart, each of them approaching at that rate, in two minutes they would be in collision, so that there was very little time for the people to think what they ought to do. They must have the instinct of what was best to do when they first saw each other. Besides this extra speed, there was the extra length of these modern steamships; and it was shown by the diagram how difficult it was for ships of that length to deviate from the course they were on for some considerable time. For some time the curve described deviated very little from the straight line, therefore, the power of gradually moving out of the course, when done by the helm alone, was very feeble. Allusion has been made to the *Thunderer*, a twin-screw ship, and no doubt one reason of her handiness was that she availed herself not only of her rudder, but of the twin-screw.

Captain COLOMB said she was very handy, setting aside the twin-screw.

The CHAIRMAN said he should like for a moment to draw attention to an improvement in the placing of twin-screws in steamers, devised by a landsman, Dr. Siemens. He was the owner of one of the largest steamships afloat, a cable ship, the *Faraday*, and he devised an arrangement by which, instead of putting the two screw shafts parallel to the keel, he made them converge towards the stern. The result was, when those screws were worked independently, that they operated to turn the ship, not by a radius equal only to the length from the centre of the shaft to the centre of the ship, had they been parallel, but they operated to turn with a leverage equal to the distance from the centre of the ship to the centre of the produced line of the screw shaft. They not only had this excellent effect in helping the ship to turn, but there was a great convenience in making the shafts diverge, because it afforded better space in which to place the engines. It might be well to consider whether that would not be an advisable thing to do in twin-screw ships in general. Captain Colomb said the first feeling of any captain in seeing danger, was to turn away from it; but he suggested that this was not, generally speaking, the best thing to do, and that, contrariwise, it was commonly better they should act on the principle, though he did not quote the words, "Resist the devil, and he will flee," in other words, turn towards, do not go away. He understood that his objection was, that if you did this you would not only be resisting the devil, but what was worse, you would be resisting the Board of Trade. That was one of his complaints, that a seaman could not do that which, in his judgment, was best without being open to the imputation of disobeying the law. He (the Chairman) had compared the Board of Trade Rules for 1882 with those of 1863, hoping to find the difference between them of which Captain Colomb complained, the comparison of Rule 18 of the 1863 edition with Rule 22; but he learned from Captain Colomb that he had not gone sufficiently far back, as the difference of which he complained was not between the 1882 edition and that of 1863, but between 1882, and an edition anterior to 1863. He (the Chairman), however, found one difference between the edition of 1882 and that of 1863, which was suggestive of the intention to do away with the option of departing in certain cases from the strict letter of the rule. Rule 18 of 1863 was the same as Rule 22 of 1882 in its operative part, that was, that where by the above rules, one of two ships is to keep out of the way, the other shall keep her course; but these words in 1663 were followed by the words, "subject to the qualifications contained in the following Articles." Then followed Rule 19, which was headed "Proviso for special cases;" the rule itself ran thus:—

"In obeying and construing these rules, due regard must be had to all dangers of navigation. Due regard must also be had to any special circumstances which may exist in any particular case, rendering departure from the above rules necessary in order to avoid immediate danger;" while the heading of Rule 20 said: "No ship under any circumstances shall neglect proper precautions." These concluding words in Rule 18, and the proviso at the head of Rule 19, made it to his mind very clear, that although it was intended under ordinary circumstances that one ship of the two should keep her course, it pointed out that the man in charge was not to run into inevitable and hopeless danger for the mere purpose of rigidly keeping the rule; while in the edition of 1882, the concluding words of rule 18 were omitted from the end of Rule 22, and the heading of Rule 19 was omitted from Rule 23. Although Rule 23 was to the same effect as Rule 19, it appeared to him that these omissions had been made with the express object of taking away all discretion. With respect to this exercise of discretion, the last speaker had referred to the case of a hansom cab and a wagon, and he (the Chairman) would accept this illustration. In driving along the road, the rule was to keep on the left; but suppose you found some other man had got there out of his road, and that if you kept the rule you would get into a collision, whereas, if you drove to the right you would not, you would, of course, exercise your discretion, and break the rule. If a man under such circumstances kept the rule of the road and met with an accident, the proper reply would be, you must have been a fool to keep to the rule. Again, it is a very proper rule that you should not take a ladder from another man's house, and if you did you might be taken up for stealing; but if there were a house on fire and people crying out for assistance, such a rule must be disregarded. Rule 18 of the 1863 edition, to his mind, told the seamen that although that was the rule, yet, under special circumstances, he must break it. Captain Colomb had put forward, as one ground for his contention, that turning towards danger was in truth the safest course, whilst turning away was not. The fact that on searching the records to ascertain what state of things had preceded collisions, it would be found that they had occurred when ships had turned away from one another, and that they had not followed upon ships turning towards each other. This argument, to his mind, was not conclusive. He said, the way to find out the cause of collision was to examine the collision and what led up to it, and if this were done, it would be found that where persons had turned away from danger, they had come into collision frequently; but that was not found to be the case where men had turned towards danger. But was that a fair test under the circumstances. Suppose there were a rule to the effect that it was better to turn away from, than to turn towards the danger, many cases would be found where men had turned away, but not cases where they had turned towards it, because, in doing so, they would have broken the rule; and thus there would not be a fair average to judge from, and, therefore, the argument seemed to him to be fallacious. He quite agreed with Captain Parfitt as to the folly of a steamer keeping on her course to the very last minute before changing her helm. He had been in the position described by Captain Parfitt, not in sailing ships, but in sailing boats, when he had been extremely uncomfortable from not being able to tell whether the steamer coming straight towards him saw him or not, until within some five minutes of a possible collision, when it appeared she did see him, as she turned aside; but he supposed it was beneath her dignity to give any information that she did so within a reasonable time; similarly, he supposed, it would be looked upon as a lubberly trick to ease or stop to avoid a collision; the idea was to keep on and see how well you could steer. All those who were expert in any particular matter, were desirous to show how skilful they were, and no accident happpened 19 times out of 20; but the 20th time something failed, and disaster resulted. You need not have got into the danger if you had only been a little bit less confident, and a little less inclined to show how clever you were. With regard to the half-educated officers in charge of ships, Captain Parfitt said he often wondered how some of the men who came before him could ever have got their certificates; it might be that a man on the deck of a ship had plenty of *sang froid*, and presence of mind, but when he felt himself pulled up, and brought before a tribunal of three fierce-looking men, and overhauled as to what he had done, his wits were not so much about him; and, therefore, he did not think it was at all certain that a man who could not answer questions, under those circumstances, was unfit for his position on board ship. He had recently returned from America, having made both passages in a Cunard steamer, and had been much interested in talking to the officers. One of them told him that there was not an officer allowed to take charge of the deck of one of those ships until he had had absolutely independent command of a vessel for five years. That said a very great deal for the care which that company exercised. But was it to be wondered at that there should be half-educated officers, and so many foreign seamen on board English ships, when one recollected how, in the interests, as it had been thoroughly intended, of the sailor, British commerce had been trammelled with obligations which did not affect other nations. We had no navigation laws restricting competition; and, as far as he knew, it was perfectly open to any shipowner all over the world to go to Newcastle and carry coals to London. That being so, we really ought to take care that in our desire of having everything extremely perfect, we did not starve and cripple our commerce so that it went away altogether. When he was at Quebec, he saw, with great regret, a large number of Norwegian vessels which, he was informed, carried timber to England. He was told

the reason of this was, they fed their men less well, paid them less well, and thus were able to work for lower freights, and the result was, he believed, the Norwegian vessels lying there were nearly as numerous as the English. That was free trade, which, of course, he could not object to; but he did say, we must be careful how we burdened our own commerce, when we allowed the most open competition of every kind, even to those who were not bound by the same restrictions as applied in this country. There was one point which had not been spoken of as a cause of collision, which was, perhaps, more for a mechanical engineer than a sailor, and that was, the effect of a screw on the course of a vessel when the engines were reversed. In the year 1876, a committee of the British Association, consisting of the late J. R. Napier, Sir Wm. Thomson, the late Wm. Froude, Mr. Bottomley, and Mr. Osborne Reynolds, investigated this subject, with the object of ascertaining, by actual experiment, what was the effect of the screw on vessels when the screw was turned astern intending to avoid a collision. The result was to show practically that that which they had anticipated theoretically was correct, viz., that if a screw steamer in imminent risk of collision stopped, and then went astern, and kept her helm in the way she would keep it if going ahead, the head of the vessel would go the contrary way to which it was intended, and a collision would be the result. This was an undoubted fact, and ought to be well-known, though he feared it was not, and that the ignorance of this fact led to many disasters. When he was returning from Malta, in the *Agincourt*, the experiment was tried, and although no very definite result was obtained, the general effect was to confirm the results obtained by the committee. He would conclude by asking the meeting to pass a hearty vote of thanks to Captain Colomb.

Mr. Forwood said he should like to make one suggestion, not his own, with regard to altering the lights. It had been suggested to him, by Captain Gibbons, that the three lights, the port and starboard, and the white light, should be in the plane of a triangle, then, whichever way the ship went, a crossing steamer would be able to judge of her position and course.

Mr. Arthur Shippey said the cause of collisions, in his opinion, was the want of more light. Nothing was said in the Act of Parliament what light should be given, and the present lights were very poor. On looking at statistics, it was evident that a great amount of collisions took place within a certain distance from the shore, and he contended, that if the Channel was better lighted, they would be prevented. He had been giving his attention for some time to obtaining better lights round the coast, and at last, Government had consented to help him. Much stronger lights could now be obtained by means of electricity, and in steamers, vast power could be obtained from the engines, or in sailing vessels, by a battery. He had been working at this for some time, but could not get a battery to work signals, except for a short space of time. During the last few days, however, he had succeeded in obtaining a battery which would give a light for thirteen days. He hoped soon to be able to provide a floating lamp at a certain distance from the shore, which would give the light required.

Mr. Vibert said, one prolific cause of collision arose from the fact that, when two steamers were in proximity, and the order on one was given to stop the engines, the escape of steam which followed, created such a deafening noise, that the orders were frequently misunderstood. Any invention, which would tend, without back pressure, to reduce that noise, would be a step in the direction of diminishing collisions.

Captain Colomb, in reply, said he might be asked why he persevered in this matter, which he had been engaged on so long, seeing that he made so little way, but the fact was that he made a good deal of way, and was exceedingly well satisfied. Mr. Liggins was perfectly right in referring to the difficulty of altering the rules on account of the necessity of consulting other nations, still they could be altered, for they were largely altered in 1840, 1846, 1851, 1854, 1862, 1868, and again in 1881. He believed he had helped to get some of these alterations made, and hoped to help in getting some more. Before 1868, the order to port under all circumstances was universally acted upon, and believed to be a sound seaman-like arrangement. He violently attacked that in 1868, and within a very few weeks of the publication of his attacks, amendments began to be proposed, and it was pointed out that this universal port-helm was a mistake. If the law, as printed, was read in that way, it was necessary that something should be done, and there were explanations published, pointing out that port-helm was to be limited. He attacked the law not only for steamers, but for sailing vessels; and the law of 1863, Article 11, which was the port-helm rule for sailing vessels was, in 1881, absolutely abolished, while the port-helm for steamers had been modified. The desirability of ships communicating to one another what they were going to do, was a point he was very strong about, and had advocated for a long time, and in the Rules of 1881, warning signals by sound were introduced. The American Government once adopted a system of visible signals which he proposed, but withdrew them under the pressure of the English Government, who suggested that it was inexpedient to adopt a plan which was not universal. First of all, therefore, they need not be afraid of advocating changes; and, secondly, it was certainly worth while to continue to do so if they were generally approved. Mr. Cobb seemed to think he was a little hard on the Board of Trade, but he endeavoured to treat this as a purely scientific question, not as a personal one at all. When used the term "authorities," he included everybody

who had anything to do with it, himself among the number. But the question was whether he was hard on the authorities. He had said supposing Y in Fig. 3 to be the keeping-out-of-the-way ship, she was not told distinctly how to get out of the way, as under the old law she was. Before 1780, he found in the instructions to ships of war, these words: "But when ships are on different tacks, and must cross near each ether, the ship on the starboard tack is to keep her wind, while that on the larboard is *always* to pass to leeward." In Fig. 3, Y would be the ship on the port tack, and X on the starboard tack supposing the wind to be from the right-hand corner. He had also a remarkable book drawn up by Admiral Kempenfelt, in which occurred this passage:—"When ships are on different tacks, and must cross near each other, the ship on the starboard tack is to keep her wind, while that on the larboard is *always to pass to leeward.*" Coming to the Signal Book of 1799, he found:—"When ships on different tacks must pass near each other, the ship on the starboard tack is always to keep her wind, and that on the larboard tack is always to pass to leeward, bearing up in time for that purpose, if necessary." That was the old law; the ship was to bear up; she was not allowed to cross, or attempt to cross the path of the other. Then came the new law, and he found, under all circumstances, a different class of words was used. Article 14 put it:—"That when sailing ships passed each other (under certain conditions), one of them should *keep out of the way* of the other." Section 16 said: "If two steamships are crossing the ship which has the other on her own starboard side shall *keep out of the way* of the other." The 20th was to the same effect, always using those words, "shall keep out of the way," instead of saying bear up, and pass to leeward, or pass under the stern. Next came the explanation of what these words, "keep out of the way," meant; and he would here quote from a pamphlet published in 1868, by authority, headed "Regulations for Preventing Collisions at Sea." At page 10, speaking of this very case in Fig. 3, it said, "It is clear that the action in each case must depend upon the necessities of the case, and that the Legislature cannot make a rule to say that Y shall always go one way, or always do one thing; it must be left to the officer in command to do the best under the circumstances of each case, to recollect that his green light opposed to the red light of another vessel, is the one position of danger, and, above all, to observe due caution." Again, taking a later book, published in 1881, "Regulations for the Examination of Masters and Mates in the Mercantile Marine," there was a question, still speaking of Fig. 3, "Is Y to stand on, and, if not, why not?" These were both supposed to be steamers, and "Y has X on her own starboard side; Y knows she is crossing the course of X, because she has the light of X on her own starboard side; Y also knows she must get out of the way of X, because Article 16 expressly requires that the steamer that has the other on her own starboard side shall keep out of the way." Question—"Is Y to port or starboard in such cases?" Answer—"Y must do what is right, so as to get out of the way of X. It is generally preferable to pass under the ship's stern, rather than attempt to cross under bows, but it depends entirely on the position and relative speed of the two ships, and, therefore, the articles wisely leave the giving-way ship to get out of the way in any manner that may be most desirable, so, always, that she does get out of the way." Again, in a very excellent book, published by Mr. Gray, in 1878, he said, "The steamer which is required by law to get out of the way, must never neglect to slow her engines if necessary, and must always be ready to go either to the right or left or astern, as may be necessary to keep out of the way." "The only excuse he could plead for not getting out of the way is, that the other one did not keep her course," so that the captain is not told distinctly that he should never on any account attempt to cross the path of the other ship, as he was by the old law. Of course, there was a justification for the new law, and it was contained in Fig. 3. The same authoritative pamphlet contained these words: "The way for Y to avoid a collision with X is *certainly not to port.*" That was the justification for allowing Y liberty to do what she liked. The old law said the giving-way ship must pass under the stern on all occasions, and never attempt to cross the bows. The new law said, "You may always cross the bows, if you think it is the best way." Now came the other part he objected to—the order to keep your course. The Chairman had read the article, and took the same objection to it that he did—that it was too precise, and too distinct; that it really made a man avoid keeping his course almost at his peril. The words were: "Where, by the above rules, one of the two ships is to keep out of the way, the other shall keep her course." In the old law, the words always used were: "When ships are on different tacks, *and must cross near each other;*" and when the Trinity House published the first rules for steamers, in 1840, they put it in precisely the same way: "When steamers on different courses must *inevitably or necessarily cross so near*," then they were to do so-and-so; but they were never compelled to pass near one another. It was always open to ships under the old law, even as late as the Trinity House rule of 1840, to avoid that proximity which was spoken of by Mr. Glover as being the cause of so many accidents. That was so up to the publication of the rules in 1863. In 1844, a summary of these rules of the road was largely circulated, called Chapman's Rules, which were drawn up by a committee of shipowners in Liverpool, assisted by Trinity masters. They speak of this order, that the ship on the starboard tack is to hold her wind against a free ship; but they always said then it was the right of the holding-on ship to go on, but it was also, *in a certain sense*, her duty to go on, There were very great qualifications; it was only in a certain sense her duty to go on, and it

went on to say, if the holding-on ship had the least idea she was running into danger, she was not to insist on keeping her course, but she was herself to bear up. That was the law as published in 1844. The new law he had read, and the gloss upon it given in the catechism, was this:—"Where by the rule one of two ships is required to get out of the the other's way, what was the other to do?" "Answer—To keep her course. This is absolutely necessary, to enable the commander of the ship, required by the articles to keep out of the way, to act with precision and promptitude, which he cannot possibly do unless he knows what the other vessel is going to do." To show how the Courts acted on this point, insisting on a vessel keeping her course, he would refer to two cases. The first was that of the *Jessore*, which was a sailing vessel on the starboard tack. She saw, a little on her port bow, the green light of a steamer. She waited for a time, seeing that this green light was not altering its bearing. To avoid the danger she starboarded her helm—doing, in fact, what he had been preaching was the right thing to do. While she was starboarding, the steamer saw her, and ported her helm a little to the red light, which she saw on her starboard bow. She had barely ported her helm, when she saw the green light of the sailing vessel appear; she immediately put her helm hard-a-port, and cut off the stern of the *Jessore* and sank her. The decision was that the steamer was perfectly right, and the sailing vessel was wrong. The next was the case of the *Avalanche* and the *Forester*. The *Avalanche* was on the starboard tack clean full, and the *Forester* was on the port tack close-hauled. The *Avalanche* saw the green light of the *Forester*, and continued to see it on the same bearing, and getting seriously alarmed at the danger she made every sort of signal, and then put her helm to starboard and brought herself close to the wind; so that she went as near to the position of X in Fig. 9, as it was possible for a sailing vessel to do. She had lost her way by the time she had got nearly up to the *Forester*. The *Forester*, in the meantime, had seen her danger, and put her helm up in the proper way, trying to do what Y did in Fig. 8. The *Avalanche* having lost her way, fell off and struck the *Forester* on her port side, and both ships went to the bottom with a large loss of life. The decision in that case was, that the *Avalanche* was perfectly right, that it was her duty to keep her course, and that she would have been wrong to attempt to avoid the danger. Having stated these cases, he did not think he had been too hard on authority. To refer to the discussion on Wednesday night, he did not agree with Mr. Cobb that a bad look-out was so great a cause of collisions as was supposed. Table 18 of the "Wreck Register" for 1865, gave the results for the seven years previous, showing the state of the weather. With an atmosphere more or less thick or unfavourable, there were 665 collisions, which, of course, were at a time when a look-out was next to impossible; but with a good atmosphere there were 1,220 collisions. And it was a well-known fact that as the weather got thicker, and the look-out became more and more impossible, so did the number of collisions diminish. Allusion had been made to the *Princess Alice*, and it was said these things happened through disobedience to the law, and the *Princess Alice* was blamed. He would not go over that ground again, but it was quite certain the *Bywell Castle*, which ran into the *Princess Alice*, did so under a port helm, which, according to his view, was the wrong helm. He would not attempt to say whether a collision would have happened otherwise, he only knew the wrong helm was used by the *Bywell Castle*. Mr. Liggins thought he found fault with the Courts, but that he should never think of doing, because the Courts made the law. The same gentleman quoted the general opinion as being in favour of the present rules. He had the usual respect for general opinion, but he had quoted a number of changes of the law which had taken place in his time; they had all taken the place of a system which before was thoroughly commended by general opinion, and when the change took place, it was again commended by the same opinion. Admiral Moresby spoke of the distance of the vessels apart determining the law, but the distance had nothing to do with the law; the moment you saw another vessel the law came into operation. Captain Heathorn had asked as to the effect of velocity on the curve, and whether it would modify the nature of the curve described. For a number of years they had been under the impression in the Navy that the speed of the engines had a great effect on the nature of the curve turned, and that when the speed was high, the curve was large, and when it was low, the curve was small. He believed they were completely in error as to the theory of the question, though perfectly right as to the facts. When the idea was formed, they only had hand-steering gear, with hide wheel-ropes, which stretched very much; and they were never able, when the engines were going fast, to get the rudder over to its full extent. So far as he had been able to try experiments, and his experiments in the *Thunderer* had been very complete, the speed of the ship had not the slightest effect on the nature of the curve described within moderate limits. He would not say that with a very low speed, or an enormously high one, it might not differ, but within reasonable limits, the speed had no effect whatever on the nature of the curve; though, of course, the time of performance varied according to the speed. Mr. Glover had said that collisions were decreasing in number, and he wished he could hold the same opinion. Some time ago, one side attempted to prove that they were increasing, and the other side that they were decreasing; but he could not see that there was any perceptible change. He was satisfied, however, that some of the changes of the law he had spoken of had tended to decrease collisions, and, that whether they had positively decreased or not, there were not so many as would have taken place had the

law remained as it was in 1863. Mr. Glover also spoke of the advantage of giving ships a wide berth, and he could not confirm that opinion too strongly. He advocated it with all his force. He claimed that X in all cases should have the power of starboarding her helm, and that in like manner Y should have the power of porting her helm so as to avoid that dangerous proximity. Captain Parfitt had referred to Y, in Fig. 11, and said, if she were moved further down the paper, the two curves would cross one another. That was no doubt the case, but he would also find either that a collision was inevitable in that position, or else that the ships were, as he had stated in his paper, in that exceptional position where there was not room for them to pass side by side; when the path they occupied was so small, that it was less than the mean beams of the ships. He must also make the ships have the same turning powers, be of equal length, alter their helms at the same time, and be at an equal distance from the collision point. Anyone taking the figures as they stood, would see that if they put the ships in a certain exceptional position, the rule would fail, but in every other position it did not fail. He also spoke of the time occupied in putting the helm over and reversing the helm, in which he was quite right. The time occupied in putting over the helm of a ship was considerable, and when once over, it took a considerable time to reverse it, but the only result of that with regard to the diagrams, was to put the ships further apart. You would always have the same result, that turning towards one another tended to reduce the risk of collision to the minimum, whilst turning from each other had the reverse tendency. Captain Parfitt also spoke of the extraordinary words, "risk of collision;" they were modern words, and did not appear at all until 1840. The Chairman had used a word which he was delighted to hear; he said that in case of collision you must have an "instinct" as to what was right to be done. This was what he pleaded for; that you should be told by the law what was the right thing to do, and that you were always to do it. When the law did that, men would acquire this instinct, whereas it was painful to any one who was in great anxiety, seeing a ship approaching, not to know sometimes what was the right thing to do. He did not say they never could say that now, but they always had to think a great deal, and to turn it over in their minds, which was a misfortune. Dr. Siemens's invention struck him as being a very considerable advance in manœuvring power. The Chairman had also pointed out a flaw in his argument resting on statistics, because he said they did not find cases where turning towards each other produced collisions. But before 1863 there was the rule of port helm in all cases, so that when the ship was on your right hand, you turned towards her; and there were abundance of those cases. When that rule was universal, one ship must have turned towards the other, but still that did not produce collisions. He had also spoken of the advantage of stopping early, and of the danger of holding on too long. No doubt that was one of the dangers, and the best rule in the present law was Article 18:—"Every steamship, when approaching another ship, shall slacken speed or stop, and reverse if necessary." It would be an improvement if the rule applied to sailing vessels as well. Slackening speed gave time to think, if it did nothing else. The effect on the helm of reversing the screw was a very important point, and the experiments tried by the committee of of the British Association, so far as he had been able to confirm them, were perfectly just. There was one flaw, however, in their conclusions, because they always altered the helm after they had reversed the engines, and when you did that, experiments tended to prove that you lost command of the ships. Sometimes it would happen that ships would go the opposite way, but that did not seem to be the case with all ships. In fact, the report of the committee pointed out that the ships did not always go the same way. The effect was totally different if you reversed the engine after you had put the helm over. In all cases in which he had tried that experiment, the ship obeyed her helm the same as with headway, and, of course, the reason was pretty clear. The helm moved before the engines were reversed, and the ships had began to turn; moments of momentum had been set up; she was set swinging, and that would continue although the helm might have very little power. Now, the practice almost universally was to alter the helm first and the engines afterwards, and, therefore, the committee were not correct in suggesting that the order to reverse the engines was in itself dangerous. Improperly used it might be, but properly used, it simply had the effect of delaying the ship as she turned over the curve. After a time command was lost, but then the way of the ship was lost at the same time. The question of placing lights in a vertical plane had been brought forward before; it had certain advantages, but the inconveniences to ships were such as would prevent it ever being carried out *in toto*. With regard to the noise from the escape of steam, there was no doubt it would be an advantage to prevent it, and in the Navy they were now turning the waste steam into the condensers, so that that noise was got rid of altogether.

FOURTH ORDINARY MEETING.

Wednesday, December 6, 1882; Dr. AUGUSTUS VOELCKER, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Aubertin, John James, 33, Duke-street, St. James's, S.W.

Bayly, Robert, J.P., Torr-grove, Plymouth.

Cater, William, 54, Wiltshire-road, Brixton, S.W.

Goolden, George Barnet, R.N., Travers College, Windsor.
Knight, John James, Farnworth, near Wigan, Lancashire.
Stone, William Henry, M.B., F.R.C.P., 14, Dean's-yard, Westminster, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Burbridge, Samuel, 9, Blomfield-street, E.C., and Woodlands, Hither-green, S.E.
Chapman, John T., 2, Arlington-square, N.
Church, Very Rev. Richard William, M.A., Dean of St. Paul's, Deanery, St. Paul's, E.C.
Clark, Thomas Sutton, 38, Faulkner-street, Manchester.
Dysart, Earl of, 29, Chesham-place, S.W.
Ford, William Wilbraham, 9, Spring-gardens, S.W.
Geake, John B., 42, King-st., Covent-garden, W.C.
Johnson, Richard, Great Northern Railway, King's-cross, N.
Kent, Henry, The Grange, 52, Shepherd's-bush-green, W.
Sandeman, Lieut.-Colonel John Glas, Whin Hurst, Hayling Island, and 24, Cambridge-square, W.
Shand, Edgar, Adelaide-buildings, London-bridge, E.C.
Skrivanow, Gregoire, 32, Rue Vignon, Paris.
Sugg, William Thomas, Vincent-street Works, Westminster, S.W.
Wright, G. Strother, 147, Hartington-road, S.W., and 60, Queen Victoria-street, E.C.

The paper read was—

THE ARTIFICIAL DRYING OF CROPS.

By William A. Gibbs.

After fourteen more years of silent work, I have peculiar pleasure in bringing this subject once again before this learned Society, and reporting progress thereon; for it was the foresight and public spirit of this Society that first aroused and concentrated attention upon this most important problem by the offer of the large Gold Medal and fifty guineas for the best essay on "Harvesting Hay and Corn in Wet Weather." It so chanced that I had been investigating this very question for seven or eight years before that offer was made; having been impelled to take it up by seeing the ruin that fell upon the yeoman-farmers, in the neighbourhood of my estate, by the loss of their harvests in 1860 and 1861. Good sturdy, honest, intelligent fellows dropped one after another into the condition of day-labourers, and it seemed so grievous that such men should thus lose their all, after working so hard to hold their own, that I thought I could hardly employ my leisure and my means better than in trying to find some help for them. Your Society had not heard of my small doings, because I had not considered my results, up to that time, of sufficient importance to make any stir about them; but one of your members, knowing I was working at this subject, persuaded me to put these results into the shape of an essay, and send it in. I did so, and this, with some twenty others, were examined by Clare Sewell Read, John Chalmers Morton, and the late Chandos Wren Hoskyns, who were good enough to agree in awarding the prize to this. I mention these circumstances to prove what I have just stated, that it was to your Society that the landowners and farmers of this country will largely owe their future freedom from loss in wet harvests.

Shortly after, your good example was followed by the Highland and Agricultural Society of Scotland, whose council, quite unexpectedly, awarded their large Gold Medal to a still slighter essay on the subject.

Encouraged, therefore, by the fact that two most important societies considered my labours useful; encouraged also by the warm and generous support which, from first to last, I have ever received from the leading organs of the Press, I have gladly devoted my life and fortune to provide our country with an available defence against disastrous seasons. The task is not such an easy one as many might think. The enormous bulk of harvests to be saved; the great varieties of grasses, clovers, cereals, with their peculiar forms and requirements; the ever-varying and unknown quantities of water to be expelled, and the practical impossibility of driving off such large quantities of water without risking abnormally high temperatures, have involved a hundred costly failures for each success. But the small successes which were granted to me in the earlier stages of the problem, have slowly paved the way for better, and I have, this evening, the pleasure of reporting to you that tested and approved harvest-savers, in the hands of noblemen, large landowners, and farmers, in half the counties of England, have, during the last two or three seasons, saved thousands of tons of produce that must otherwise have been wasted. As to some of these machines, I have received the voluntary acknowledgment from their owners that they have repaid their cost in one, two, and three seasons respectively; so that I may now congratulate this Society on having encouraged me to per-

severe in a problem which has, at last, proved itself. To those noblemen and gentlemen who have thus demonstrated the powers of this resource, the country will also owe much of its future prosperity, for the spoliation by wet weather has been roughly estimated to impoverish us to the average extent of six millions a year. Not only will your Society, and these pioneers, have thus aided in averting this enormous loss from agriculture but you will also have helped the establishment of a new industry. In Bateman's tables as to the ownership of land in Great Britain, you will find that out of the total acreage (there given as 73 millions), nearly 16 millions are in the hands of the peerage, and 21½ millions in estates of 3,000 acres and upwards, *i.e.*, 37 millions, or about half the total acreage, is in the hands of men of wealth and position, of the same class and standing as those who have already adopted these machines.

Now, a machine, say of £350, would serve for a 1,000 acre farm, supposing the usual proportion of corn and grass is grown; hence dividing 37 millions by a thousand, gives 37,000 machines as the ultimate requirement for large landowners. From my knowledge of the hand-labour required to construct these machines, I can certify to you that this number alone would give ample employment to 7,400 skilled workmen for ten years. Again, taking each machine as weighing ten tons, this would show an increased demand for 370,000 tons of iron, and finally estimating the money value of these harvest-savers, they would represent 13 millions sterling as ultimately added to the wealth of the country. These figures, although worth some consideration, are dwarfed, of course, by the main saving to agriculture, and through agriculture to the whole country, of an average of six millions a year; and I should hardly have troubled you with them, but for the knowledge that your Society takes a wide and broad interest in manufactures as well as in arts and sciences.

When I had the pleasure of explaining these matters to Mr. Gladstone, in the early part of the year, he admitted that they were considerations of the "utmost importance to the country;" and he was good enough to give me up the audience-room at Downing-street for some weeks, so that his friends might see the models there. More than all, he promised to refer the whole matter to competent authorities for examination.

There seems, now, good hope that we shall at last have a Minister of Agriculture; and when that good time comes, I think I may fairly claim the fulfilment of that promise. This was one reason why I declined to compete at the Reading Show; but another, and still more cogent one, was the knowledge that show-yard trials in things of this magnitude are, invariably, worse than useless. I had ample proof of that at Manchester, twelve years ago, and as my experience then, and since, may be of great use to some of your members, who may be working out similar problems, and may be induced, as I was, to exhibit their results at these shows, I will briefly narrate it. A leading member of your Society, the late Chandos Wren Hoskyns, was also on the Council of the Royal Agricultural Society, and had roused this latter body to offer their Gold Medal for the best means of saving harvests. He urged me strongly to send my (then) simple form of harvest-saver to the show. I did so, at great trouble and expense. There was only one other system put in competition, and that had simply no effect whatever, so that the judges had only mine to try. They tried it thus. Considering that it was entered for drying wet hay and wet wheat, they would not try the hay-drying at all, because they thought hot air would injure the hay; and instead of wheat, they sent up green rye—raw, and full of sap, and deluged it with water. They acknowledged that "these sheaves were in a very wet condition; all soaked to the bond, and in a state which would be rare in nature." They also acknowledged that "it was abundantly evident that the moisture could be expelled," for thirty-two sheaves lost 57½ lbs. in fifteen minutes. They also calculated that the small shed which I had sent down, and which was only twelve feet square, would have cleared over two-and-a-half acres in ten hours. They further admitted that the essay had explained how, by merely increasing the area of the shed, and putting increased velocity on to the fans, a farmer could clear five, ten, or twenty acres a day as easily as two-and-a-half; but twice twelve making twenty-four, and twice five making ten, was too difficult a sum for them to work out, so they scared away the farmers from adopting this simple resource against disaster for at least another ten years. I may say, that it had been abundantly proved before, and it has been still more fully proved since, that but for this "scare," this resource alone would have saved millions for the country, and hundreds of farmers from ruin.

The Reading Board of Works, having bor-

rowed one of my large harvest-savers, from Lord Ashburton, entered it for trial at the recent show. In the first half-day's trial of the harvest-saver, this machine converted coarse, wet, dirty marsh-grass into thoroughly dry, decent quality hay, at the rate of twenty loads a day, and at a cost of 6s. per load for labour and fuel. This hay was afterwards critically examined by experienced hay salesmen, and by one of the best practical farmers in the county, who had received a special prize from the Royal Agricultural Society for his knowledge of farming, and who was therefore certainly not prejudiced against the society; and the unhesitating assertion was, that this hay "was as good as could be reasonably expected—as good as if it had been made in fine weather, and at least 50 per cent. better than any made by the other process."

Perhaps the best service I can render this evening, is to endeavour to explain to you, and through you to the world, the various means of saving our harvests which I have tried at various times; because it is very needful to know what will *not* do before we can have a hearty confidence in what will. If I weary you with too many descriptions of my barnful of failures, kindly give me an expressive murmur of dissatisfaction, and I will instantly consign them to the limbo of oblivion. First and foremost then, let me say to all who are interested in this subject, that I don't think they will find any form of cylindrical or rotatory action answer for fibrous products like hay, straw, and their congeners. I have had cylinders constructed for tea planters, many of whom have adopted them with great advantage, and for "conditioning" corn and all granular products, but for all long fibrous matters they are hopelessly unfit—rolling it into great ropes, and curling or tangling it in a most disheartening manner.

Kiln floors and hay-tedders, or kiln floors and hand-forks, although apparently good and simple, are also distressing in results; seeds shake through and burn, or stick in the mesh and scorch; the hay-tedders knock the crops to pieces, and the "hand-forkers" get suffocated and cross, and want so much beer that they are apt to go to sleep over their work; also, they are apt to get the points of their forks stuck in the wire-net of the floors, which is bad for the floors, and provocative of worse language from the men.

Endless bands, either with tines on them, like elevators, or plain, like huge jack-towels, are also disappointing. They carry the crop along well enough, and, by driving hot air over it as it moves, it can be partially dried; but this movement is not enough; large masses of clotted wet grass require to be shaken loose, so that the hot air may permeate through every fibre; failing this, the masses scorch on the surface, and remain wet in the centre. I spent at least £1,000 over this form of machine, and made it answer for drying cotton-waste for gun-cotton at H.M. works at Waltham Abbey, and it will do for other short fibres, but it would not do for harvest saving.

Sheds with shelves or racks in them, in which the crop could be housed and dried, have the charm of exquisite simplicity; but this arrangement also leaves the clotted masses untouched, and overdries that which was already dry enough. Besides which, if of wood, they are apt to burn down, and if of iron they are expensive, because if a farmer desired to clear ten acres in 24 hours, he would require ten sheds of 45 feet long by 15 feet broad, or one stupendous building of 150 feet by 45 (vide "Essay," page 8.)

The reason why so great shed-room is required, is that the temperature used cannot safely be above 180° or 200° at most, and thus being below the boiling point, is more to be considered as a "cooking" or "stewing" heat, rather than a drying one, hence the process is slow without being sure. I have wasted my substance on scores of other modes and movements—as you will see if you will kindly look at and pass round these diagrams—but much as I should like to do so, I must not weary you with descriptions of any more of my multitudinous failures. I should like now to show you how I obtained the first glimmering of success, in this very rough model, which I fear you will look at with the scorn and contempt that it richly deserves. The poor little wretch has been cruelly used (and abused), for nearly as long as its constructor, and like him, shows grim signs of wear and tear. But this old rusty contrivance will serve to show what is possible with very simple means.

These means are simply a box in which coke is burnt, and the fan which takes this pent-up sunshine and converts it into a sirocco. In the full blast of this sirocco (scoring a temperature of say anything from 520° F. downwards), we spread wet grass, and in from four to six minutes convert it into hay. There is the germ of the whole matter. There is the first feeble breath of power drawn from nature by the simples-

art. There is the baby harvest-saver which has grown into a monster of eleven tons weight, with lungs of red-hot carbon, wings of greater speed and strength than an eagle, joints of brass, and arms and muscles of iron. A monster which, when in action, eats up a one-horse load of coke, draws off ten to fifteen tons of water, and converts twenty great cartloads of wet rubbish into good stack-hay in a single day's work.

The Reading judges borrowed a small witticism from a small and dirty boy of the town, and christened the two parts into which this affair is divisible, "Jumbo" and "Alice." But they flattered me too much, in thus comparing it with that miracle of silent and sagacious power, the elephant. I regret to say, that my elephants are neither silent nor sagacious, they are far uglier, much more clumsy and unwieldy, and so stupid that they cannot even walk alone; but they have the advantage of not wanting anything to eat when they are not earning their dinners, and they can do some few things that an elephant cannot. Still I accept the simile as a very great and undeserved compliment, being fully aware that the subtlest combination of man's hands are far away behind the simplest creation of God. Look, for example, at the model of this other thing; what a poor imitation of the elbow, the arm, and the muscle is made by the crank, the tine, and the string; and see what a clumsy see-saw action the floor has to make, in order to bring the hay into range of the iron arms. Consider also, what a dark and dismal mockery of bright sunshine and an east wind blowing over a hay-field is made, by drawing hot air from coke and sending it through great iron mouths; and yet, when these fresh, lavish, and glorious gifts of nature are denied to us, it is surely better to use these bad imitations, rather than sit with despondent eyes, watching the golden harvests turn to dirty dross.

For the two past seasons I have, in compliance with a desire expressed by many, reduced these machines to nearly half the size, half the weight, and half the cost of the largest ones. By dispensing with one line of cranks and tines, and substituting for the huge fans and furnaces a battery of smaller fans, and a long furnace common to them all, the whole machine can travel on four wheels with four horses, like a huge wagon, and needs no taking apart or putting together.

With one of these, at the Duke of Northumberland's Albury-park estate, 210 loads were saved at the Home Farm. It was then lent to Dr. Tristram, who converted a stack of utterly useless mouldy hay into provender worth £4 10s. a load; and, finally, to one of his Grace's tenants, who saved fifty acres of aftermath, which he admitted must otherwise have been spoilt, and thus, as he also acknowledged, saved a sum equal to the first cost of the harvest-saver in a single season. His Grace has since purchased another of these for Alnwick; and about ten more of this form are in the hands of country gentlemen, who have each been good enough to testify to its usefulness.

With the desire to give additional usefulness, I have devised a cylinder to replace the tines after the hay and corn harvest is over, so as to convert the machine into a portable kiln for malt, hops, or corn. This helps to make the thing a sort of "general purpose" implement, and gives me an additional excuse for calling it a "harvest saver" in a wide acceptance of that term. Mr. Lyon, of Johnson Hall, Eccleshall, adopted this addition, and speaks very highly of it.

I was still very busily thinking out further improvements of this resource in the autumn of 1880, when a sudden *furore* arose in favour of stack drying. This marvellous inspiration came upon the public like a tornado, and almost blew our heads off. I and my wicked "costly" contrivances were instantly consigned to contempt, and a perfect fan mania set in. Sober, sensible men vied with each other as to who should put up the greenest of grasses, and the wettest of hay, and a trumpet blast of triumph, blown from a thousand fans, proclaimed the new "Eureka!" Although I had my own opinion on the matter, and certain misgivings of future disappointment for the enthusiasts, I felt bound in honour to advise those who had adopted my system to wait and see if stack-cooling would do instead, as I had certainly no desire to tempt them with expensive remedies if cheap ones would do.

You will sympathise with me for a few moments, when I venture to remind you, that if this new process was really all-sufficient to save our harvests, my twenty-two years of study and experiment, and my £10,000 of expenditure, were alike utterly wasted; the purpose of my life destroyed at a single blow, and the sole reward for all my labour, pity and derision. But it would have been too childish to whine or sulk, simply because the great desire of my heart, the safety of our

harvests, was said to be accomplished in another way, and hence I tried what could be done to help this new plan heartily and loyally. I referred to the Society of Arts Essay, and found that I had described a very similar plan, that had been patented twelve, or fourteen years ago, and concerning which I had interchanged letters and opinions with the patentees. Although it had been then much encouraged, and my Essay itself had, in its second and third editions, given a wide publicity to it, the method did not seem to have been adopted with any measure of success. I published this circumstance as a caution to the sanguine; but, at the same time, I published equally widely the evidence which had since been given by Mr. Neilson and his disciples, and strongly advised all men to try this plan first. At the same time, I turned my old experience to some account by devising a harvest-fan of such a form that, if stack-cooling did not answer, this same fan could be used for hot-air drying, and I volunteered to exchange them afterwards for larger harvest-savers without loss to the purchasers. My object in making this offer was, that men should not be disgusted by wasting money on one system, and thus be too disheartened to try another. My small efforts in this direction were kindly appreciated, for a large number of these were quickly ordered, indeed, so many, that my engineers, although working night and day for about six months, could not keep pace with the demand.

To prove that I had loyally tried, and to some extent succeeded, in devising the best implement for this purpose, I may mention that, when tested at Reading, this fan raised one inch of water with a proportionate power of 4,983; whilst, for the same result, Greening required 7,947; Phillips, 9,770; Lister, 11,480; Bamlet's, 26,500. But before permitting these fans to be sent to or tried at Reading, I had written to the Secretary of the Royal Agricultural Society to say distinctly, that if the award was given to "stack-drying," that award should of right go to Mr. Neilson, whether he competed or not, and however much better my fan might be than his. For when I first devised this small affair, and made this offer to the public, I was not aware of any besides Mr. Neilson's and my own, and had not the remotest conception that there was going to be the hurly-burly, furious fan-battle that afterwards broke out at Reading, and in which I declined to join. Here is the effigy in *petto* of the thing about which I have been speaking You will see it is much smarter and a good deal simpler in construction than my poor old hot-blasts. Having but one inlet instead of two, it is more easily adjusted, either to a shoot from a stack, or to a furnace for a hot blast. It has some other little niceties of construction inside, but I must not weary you with such trifles as these.

One, two, or three of these things attached to a fire-box on wheels, and driven by the revolution of the travelling wheels, give a strong and effective blast on to hay in rows or beds in the field, or on to sheaves of corn in "stock," so as to aid nature in some degree by art.

Perhaps it may interest you to know that I should have had a machine of this kind constructed many years ago, but for my own folly in trusting to hypothesis rather than experiment. By *à priori* reasoning, it seemed perfectly certain that if we delivered a passing blast of hot-air on to a wet substance, so as only just to warm it, and cause it to evolve some vapour, and then allowed that substance to cool before another blast was delivered on to it, a large part of the effective power of that second blast would be wasted in again bringing that substance up to the evaporating point. May I ask the scientific men here to-night if they would have agreed in that reasoning, or whether they would at once have seen the fallacy of it?

The fallacy is this. When the blast is withdrawn, the warmed substance (at least in the case of grass) continues to evaporate, so that when the blast comes back, there is less moisture to be dealt with. The proof of this was very interesting, and very easy. By drying ten ounces of grass straight off at once, with a hot-blast of 480°, we reduced it to four ounces in six minutes. Now, taking another ten ounces, and maintaining carefully the same temperature and same speed of blast-fan, we subjected this to a succession of blasts of one minute's duration each, taking it away, and allowing it to become perfectly cold in the intervals. After five of these intermittent minute-blasts, the ten ounces were reduced to three and three-quarter ounces, showing a gain of one out of six in favour of the intermittent process. I didn't believe it—rubbed my eyes, tested the balance, cross-examined the weights, and tried it again, with a precisely similar result. Scepticism after this was difficult, so we carried the experiment a step further, and weighed another ten ounces, and dried it with half-minute blasts and cooling intervals. After eight of these half-

minutes (= 4 m.) the 10 oz. was reduced to 4 oz., showing thus a gain of 2 in 6 in favour of intermittent drying. This was also repeated, and quarter-minute blasts tried; these showed still a proportionate reduction; but as it is exceedingly difficult to time quarter-minute work with accuracy, I will not ask your belief as to this last experiment. The others indicate that succesive and alternate increments of heat are more effective in expelling moisture from grass than a continuous high temperature; upon this, then, is based the probable future utility of field-dryers. I will endeavour to place before you the advantages and the disadvantages of this new mode, as contrasted with large machines.

The first advantage would seem to be a saving of two-sixths of the fuel; but this would be, to a great extent, neutralised by the greater radiation, and still greater waste, of hot-air. The second would seem to be a saving of two-sixths in time; but that would be much counterbalanced by the smallest possible shower falling while the process was going on, or even by a saturated condition of the atmosphere. A third would seem to be that it was taking Mahomet to the mountain, rather than the mountain to Mahomet; but then Mahomet would have to walk round the mountain so many times, that I am afraid he would find it as "broad as it was long," and would almost prefer sending his horses for the mountain, after all. It is clear that this process would not do whilst the rain was falling; nor when the fields were very soft; whereas Jumbo and Alice can keep jogging on through the rain, even without a shed over them, and as they do not walk about the fields, it does not matter how soft they are. Still there are many ways in which the field-dryers may be very useful. Being moderate in price, and the fan part of them being available for two purposes, they will suit the pockets of the small farmers, and the large farmers might have three or four of them to follow one another quickly, and do a large stroke of work in every decent interval of dry weather. For still larger holdings, a very large fan could be pushed about by a traction, or drawn to and fro by the steam plough-ropes; when used either with horses or engines, they could be so adjusted to hay-tedders as to blow through the grass as it was flung up, or lifted up, by those popular and useful aids to harvesting. Finally, although the thing *can* move, there is no law of the Medes and Persians that it *must* move. When field work was not possible, it could do good service in other ways as a stationary machine. An ordinary horse-gear, such as few farmers are now without, or a small steam-engine, can get out of these fans and fire-boxes such a very respectable hot blast, that not even the metaphorical "wet blanket" would care to stand too long before it. This hot blast, thus easily obtained, can be used in many simple ways. First, by merely shaking out the wet hay before it with hay-forks; partially drying it one day, and then leaving it through the night (under cover, of course) to evaporate by its own initial heat, and finishing, in like manner, on the second or third day. Secondly, by adjusting the simple lever movement, described in my "Highland Society's Essay," so as largely to aid the men in thus shaking-out. And thirdly, by reverting to the sheaf-tubes, described in the other essay, for drying wheat in the sheaf. With these two arrangements, both of which are quite within the means of a small farmer, a man might make himself quite certain of securing these two chief crops; and having convinced himself of the utility of the resource on a small scale, he could add to its capacity, in proportion as the harvests so saved gave him the means to save more. I know that farmers don't care to read essays, and I must confess, that they are rather dry reading, especially on such a dry subject as this. So I will try and explain what a sheaf-tube is. It is simply like a gun-barrel open at both ends, and about eighteen inches long; such tubes as these are stuck into sockets all over a plate-iron floor, at just such a distance apart as will enable a wheat-sheaf to be comfortably spiked upon each tube. The floor, with its small forest of tubes, is laid, air-tight, upon a dwarf foundation wall of about two bricks high, with a partition down its centre. The hot-blast is then blown into the closed space thus formed between the ground and the tube-floor, and rises through the tubes into the sheaves just where they are generally wettest, viz., at the band. A simple "shunting" valve directs the hot air first under one half of the floor, and then under the other, so that while the sheaves on one half are drying, the others may be lifted off and replaced with more wet sheaves. That is all that is absolutely essential. When you are certain that the plan is sound, you may put on a roof, or even go to the luxury of sides and ends, so as to dry quicker, but make yourselves certain first. We are told of a good time coming, when our swords are to be turned to plough-shares and our spears to reaping-hooks; perhaps in that day we shall also find

a better purpose for our gun-barrels than that of blowing out each other's brains, or crashing each other's bones, for they really would make splendid sheaf-tubes—much better than we can afford at present; 10,000 stand of rifles, if converted to this purpose, would save 960,000 sheaves of wheat in every twenty-four hours; whilst the nitrogen now blazed away out of them would have helped to grow that wheat. But destruction still reaps all the honour and glory of this world, and creation (except the creation of gold) gets all the "kicks" without even the "ha'-pence." The millenium, though not, I hope, past praying for, is evidently such a long way off, that meantime I must advise you to get your sheaf-tubes and floor from your village blacksmith, and to do without the nitrogen as well as you can. Having thus attempted, roughly, to explain both the past and the present resources for saving our harvests by mean of hot air, may I endeavour to do the same for what will probably be the future? I mean the proximate future, not that of another generation. In that I trust the large and splendid suggestion of your gifted Chairman of the Council will be brought to bear upon the wants of agriculture, and the wasted energy, now lying like sleeping giants at the pits' mouths of our enormous collieries, will be transformed by the hand of science into electric heat and power, and sent like tamed lightning to do good service in our fields. Meantime, I feel assured that Dr. Siemens, and all scientific as well as all practical men, will say to those who are suffering, year after year, the loss of their harvests, "Use such resources as science and practice have already found and proved for you, and do not wait for some ideal perfection. No doubt, in time, we shall be able to tame the lightning for you, and to provide you with much better things than these; but if you drop your substance whilst looking into the future for shadows, you will not have the wherewithal to purchase these 'better things' when we place them before you." Beside which, consider that better means do not render former resources useless. We still use carriages and horses, although railways are three times as fast, and infinitely cheaper. The horse-plough is by no means obsolete, although steam-ploughs and diggers can do ten times the work; and we still use hayforks, although the hay-tedder is far away more powerful. In this matter of harvest-saving, if the farmers had not been scared away at Manchester from adopting the simpler resources, these resources would, by this time, have saved the country some millions sterling, and even now would have still been most useful auxiliaries to the larger and more powerful ones since invented. It was not, and never has been, my personal wish or ambition to devise these gigantic automata. My first and greatest desire was to help those who most needed help—the yeomen farmers; but when, on the one hand, the Royal Agricultural Society frightened these men out of their wits, and, on the other, I was constantly urged by the great landowners to provide them with large labour-saving machinery, I was compelled either to throw up my task in disgust, or to follow it out in the way suggested. I can now advise farmers to "head back" to these simpler aids (with the most perfect disinterestedness), for during these twelve years of apathy and obstruction, my patents for these simpler devices have expired; so they will not have to pay me even the peppercorn royalty which I might, perhaps, have claimed from those who could have afforded it. One word here in defence of my imputed selfishness in "patenting." I did not wish to do so, considering it a matter that should belong to the nation; but your late Secretary, Mr. Le Neve Foster, counselled me strongly to patent, not with any view of making money, but to prevent unscrupulous men from foisting bad imitations on the public. He instanced Dr. Arnott, who was, I believe, a distinguished member of your Society, and told me that he abstained from patenting with a like idea to mine, and that the result was a flood of imperfect imitations of his system, which brought that system into undeserved disrepute. I feel sure that his advice was good, although it has entailed upon me a terrible increase of worry and loss; perhaps if it had been possible for Mr. Neilson to have done the same, it would have been better for the country, although worse for himself; but unfortunately a process analogous to his had already been patented by two gentlemen near Liverpool, who, oddly enough, had taken out their respective patents within a day of each other. A splendid instance this of the impartiality and perfection of our present wise and beneficent Patent-law!

Having ventured to name Mr. Neilson, I will, with your kind permission, defer the description of my latest model, until after I have done such justice as I can to the valuable aid to harvesting which he has skilfully worked out. He, like myself, has been working at this problem for some twenty years or more, and during the last six years he tells us he has

not had any crop spoiled. This process may be briefly described as one in which the heat generated by the fermentation of the hay or corn in the stack is used to evaporate the excess water still remaining in the whole bulk. It has recently been pointed out by Mr. Woodland Toms, F.C.S., in his able and exhaustive articles in the *Field*, that in order to get rid of five tons of water from hay stacked moist, and dried by its own heat, 14 cwt. of the most valuable constituents of the hay are consumed.

A similar view had already been taken by Dr. Voelcker in his paper in the *Journal of the Agricultural Society*, by Mr. Boyd-Kinnear, and by the editor of the *Journal of Science*. This resolves the process into an equation of values. A farmer must ask himself, "Is it worth while to sacrifice a part of the crop, in order to garner the rest and save it some days earlier than usual?" In a climate so fickle as ours, just think what an advantage it is to be able, say on a Saturday night, to cart up a fine field-full of nearly made sweet hay, lacking only two or three hours of wind and sunshine to render it perfect—to send all hands to cart up merrily, instead of leaving it to the (un)tender mercies of Saturday night's rain, Sunday's glare, Sunday night's thunder-storm, and a week of broken weather after! What is the loss of 14 cwt. in a twenty load stack, compared to the wretched depreciation of quality which follows from a week's washing when hay is made. For this resource the farmers of England will have henceforth to thank Mr. Neilson, whose patient skill has shown them how to do this, and much more.

Whether it is really safe to depend solely upon stack-cooling for all our crops, and in all sorts and conditions of weather, seems now to be greatly doubted; but I hope we have here to-night many gentleman who will give us their experience and their opinions on this subject.

have already collected and condensed all the past evidence in favour of stack-cooling which was available at the beginning of this season, and this evidence will be found in "Plain Facts"—a copy of each will, I hope, be accepted by all who are kind enough to listen to me this evening. From about 120 estates on which my Duplex fan was adopted, 20 favourable reports have been sent to me, some stating that the system had done them really valuable service; others, that the fans had done all and more than they expected; and others that, although not absolutely required, the possession of a means of reducing the heat of their stacks was a relief from great anxiety, and emboldened them to carry their hay earlier than they would otherwise have dared. I regretted to hear that Sir Gilbert Clayton East and Mr. Deane, of Uxbridge, had several stacks injured by heat, after sending me their reports; but these are the only disappointments that I have heard of out of the 120. I am told that the majority of those who adopted these fans, got their hay well forward in the field, and did not expect so much as the Reading judges. I would ask leave here to correct a slight error made by these judges. They satirically remarked, in their report, that the quantity of black hay at Whitley Manor Farm was a proof of the great faith in Mr. Gibbs's system. On the contrary, it was too great faith in stack-cooling which produced that result, and Jumbo had to go to the rescue. All the same, I must do these gentlemen the justice to acknowledge (with thanks) their admission that my process might certainly be useful where large quantities of irrigation grasses were grown. This is a large, though reluctant, admission, and is perhaps rather more than confirmed by Mr. Champion's recent report to the Farm Committee. The gist of this report is that the harvest-saver enabled him to make 90 tons of hay out of such grasses, and to use it at once as dry food for his stock, thus saving a vast expense in the purchase of other feed; also 95 tons of stack-hay, the cost of which, for fuel and engine, was 2s. 6d., and 10 per cent. wear and tear, 1s. 6d. per ton. The labour he found to be less than if made in the field, even if field-making had been possible.

These facts open up for the whole kingdom a very large question. What to do with our sewage is perhaps the most perplexing difficulty of the day. It seems monstrous to waste such an enormous value, and, worse, to pollute our rivers, and poison our sea-side cities, with what is convertible into gold; and yet hitherto sewage irrigation has seldom, if ever, been profitable. Immense quantities in successive crops of fine rye-grass can be grown, but the demand being but limited and seasonal, it was no use growing it. The huge per centage of water made it almost impossible of conversion into hay. Now that it can be so converted into valuable food, either for use at once, in lieu of corn and cake, or kept for any length of time, the *Pons Asinorum* seems easy enough to cross. In this country the demand for hay is simply unlimited, and hay can now be made in all weathers, in all seasons, and in

all quantities. Every city and town in the kingdom, therefore, can now get rid of its difficulty, without incurring loss, and perhaps, indeed, with a fair profit; and a vast addition to the meat-producing stores of the country will be thus made, whilst our rivers and our coasts will be freed from a dangerous and disagreeable nuisance.

Mr. Neilson's system was, by my especial wish, tested at Reading before my process; and was not found sufficient, but I still think it will prove a very valuable aid in this good work. I would ask your especial consideration of this branch of the subject, because it is not so much a landowner's and farmer's question as a citizen's question, indeed, an every man's question, affecting at once the health and wealth of both town and country. I am told, upon the very best authority, that Croydon is incurring a loss of £10,000 per annum, by its praiseworthy efforts to introduce and perfect sewage-farming. The members of the Board, after several visits of investigation to my place and other estates, and after testing the smaller harvest-saver through a season, wished me to have a very much larger "machine" constructed for them than any yet made, and the farm manager, Mr. Alex. Marriage, is strongly of opinion, that this system would save them from future loss; quite early in the season he wrote to say, that if they had had the harvest-saver, they could, even by then, have saved its whole cost. I declined to have this made for the past season, chiefly because I wished them to wait and judge as to stack-drying. Now, if £10,000 a-year can be saved in a single town, we can calculate roughly what will ultimately be saved for the whole country. Before passing from the subject of stack-cooling, I should like to take the opinion of any practical farmers present, on a small and simple modification of the present process. In my county, the farmers use an iron stack-borer, that will cut a six-inch hole down to any depth, so that if a stack shows signs of undue heat in any one part, they cut a hole at that part to let it out; but they complain that the heat will not come out fast enough. Thereupon I devised for them, a light small fan with a six-inch inlet, that could be carried up to the top of the stack and stuck into the hole. From that exalted position it could be either worked by a strap from a chaff-cutter wheel, or by a sweet little cherub, in the shape of a farmer's boy, who could be "sent up aloft, to look after the fate of poor stack." My farmers are delighted with this idea. What do you say to it, gentlemen? Will it do? It may save us from leaving a big hole in the stack, which, after all, we may not want. It may save us a lot of money in pipes, and valves, and junctions, and big fans, and it may draw the heat out from whichever side the outer wind has blown it to, without over-cooling the side which is already cooled too much; so it is perhaps worth thinking about.

A paper on "Artificial Harvesting" must, of course, take cognisance of the latest revival, "Ensilage." The enthusiasm that set us all fanning last year has cooled itself down by its own wind, besides having had a considerable excess of cold water thrown on it at Reading; hence we are urged with equal fervour to bury our treasures in the earth, and rest in peace, in the hope of a happy *Resurgam*. Doubtless, there is some philosophy, and some common-sense in this also; the evidence given of its value is very strong. We have the analogy of brewers' grains to show that wet and watery stuff, when well rammed down, will keep without going unwholesomely sour for a fairly long time. I ventured to give a few words of caution, in the early part of this year, as to stack-cooling; may I be allowed to give a few more now as to ensilage? They are, perhaps, hardly needed, because Sir J. B Lawes, Professor Voelcker, and many others have already done so. At the same time I would say to all who believe in it, "Try it, by all means;" but do not stake too heavily upon it. It may be good for others, and yet not suitable for you. The alcohol and vinegar that is generated may make the food flavoursome and even wholesome—it may produce increased secretion of milk, and that milk may produce its fair proportion of butter and cheese, and your cattle get as fat on this mixture of sweet, sour, and spirit as on the usual diet, and your cows may live as long and die as happily as before—but it will take some time to prove all these things, and yet you will perhaps agree with me, that all these things should be "proved" before you revive this revival too extensively. I would say, do not despise any evidence, do not neglect any resource; the world is wide enough, and the need is sore enough for every aid that science or experience can bring to bear upon the prosperity of agriculture.

The mode of making silos, and all the arrangements have been so exhaustively described in all the agricultural papers lately, that it would be mere impertinence in me now

to attempt to better these instructions; but perhaps the system of five moderate-sized pits, described in the *Agricultural Gazette* of the 20th ult., rather than the very huge ones described elsewhere, will approve itself to most practical men as the better of the two. These five cost £150, and were calculated to store eighty tons of rye cut early in June.

I wrote to Mr. Edmund Gibson, of Saffron Walden (the gentleman who has adopted this system), to inquire if the eighty tons of rye filled the whole five, and he was kind enough to explain that, although the pits were not full, they were as full as they could be, so as still to leave room for the men to trample the rye down. This gives us important data as to the cost of harvesting our crops in this manner. The eighty tons of rye contained seventy-two per cent. of water some months after it had been stored; so that, roughly speaking, the eighty tons represented about twenty-five tons of dry food. If we take 250 tons of hay as the produce on a good-sized farm, and depend upon the pit system for saving it in wet weather, we should need fifty pits of the size adopted by Mr. Gibson, at a total cost of £1,500.

Mr. Christy's letter in the *Times*, describing Mr. Hoare's silo, says: "The inside measurement was 24 × 10 × 10 feet, built of stone faced with cement, in a barn." This held the produce of 3 acres of trifolium estimated at 50 tons, and as equal to "8 tons of hay, if dried."

A contractor refused to make me a pit of that size for £50, but supposing it could be made for that sum, then for each 24 tons of dry hay that we wished to save in the shape of ensilage, we should want three pits, costing £50 each = £150; and for 240 tons we should have to spend £1,500.

At the Duke of Northumberland's estate, Albury-park, more than 250 tons were saved by a £210 harvest-saver, so that the silo system seems a good deal more in first cost than the drying one.

Earl Granville has been good enough to send me a copy of the "Blue-book" (laid before the House in June, 1882) containing the statements as to Mr. Mills's two silos in America. These are described as 40 feet long, 13 wide, and 20 feet deep, constructed with walls 2 feet thick, made of concrete, stone, and cement. The cost is named as about 700 dollars, and the contents 600 tons of maize. This 600 tons of maize is stated to have been grown on 13 acres. It is very difficult to reconcile such figures as these with Mr. Gibson's and Mr. Hoare's absolute experience here in England; and it seems almost like one of those, not infrequent, cases where "distance lends enchantment to the view."

I obtained an estimate from a contractor in my neighbourhood for two pits exactly the same as described by Mr. Mills, and find they would cost me £780; where gravel for concrete can be had on the spot, they might possibly be had for £400. These two pits would hold nearly nine times the quantity of Mr. Hoare's, *i.e.*, as much ensilage as would represent 72 tons of dry hay. Hence, to save three times that amount, viz., 216 tons of dry hay in the condition of ensilage, would seem to require £400 × 3 = £1,200 outlay.

Although rye-grass is said to be especially suitable for ensilage, it so chances that on sewage and irrigation farms, where rye-grass is chiefly grown, the great requirement for stock is dry food; there is always a superbundance of wet diet, in the successive crops of the grass itself, and it was by having the facility for turning a part of this into dry chaff, that Mr. Champion, at Reading, was able to report so large a saving to the Farm Committee.

There is a general opinion that one great cause of failure in stack-cooling was the finer and softer grasses grown in the south, as compared with the strong strawy rye and clover growths, and I much fear that these softer grasses will be "risky" for ensilage also, unless mingled largely with straw. Our upland meadow grasses go mouldy with a startling rapidity, if put into large cocks too soon, as I found, to my cost, last year, when following Mr. Neilson's instructions.

May I now attempt to describe to you my very latest (possibly my very last) attempt to be of further service to the farmers? We have here got a step beyond the arms, the elbow, and the muscle, and substituted the fingers of a giant's hand—all iron, of course, as a giant's hand ought to be. Underneath each of these six-fingered hands are flat iron plates, to which a very rapid shaking action is imparted, so that when one set of fingers shake the fibrous stuff off its points, or through its spaces, the plates shake it down to the set of fingers below, and thus down and down the whole distance—in point of fact, mildly, but firmly "kicking it downstairs." These big fingers are moved very easily by one long lever acting on a number of short ones, so as to give a series

of jerks, which effectually disintegrate and pull to pieces the most obstinately attached fibres. The flat plates have another function besides that of shaking, for they form huge louvres, like those of a huge venetian blind, through which the hot-air (drawn out of the furnace by the fan) is driven and dispersed amongst the cataracts of hay or corn. The movement given to the plates is an important part of the construction, especially when it is desired to have the troughs of great length without raising the feed-end too high. These plates act as carriers to send the hay along, and also as pushers, or scrapers, to prevent it from lodging on the fingers. The adjustment of the fan and furnace is also more compact than in the other machines; but perhaps the best thing that can be said for this latest form is that it can be constructed of any size that the extent of the farm, or the desire of the farmer, may require It can be shortened and put on wheels, and attached to a hay-tedder, so as to catch and dry the fountains of wet grass thrown up on to it, or it can be elongated so as to make it perfectly certain that the very wettest grass taken out of flooded meadows shall come out perfectly dry at the other end. It can be made of such bulk as to absorb the whole available power of the largest traction engine, or of such modest dimensions as to be easily added to a duplex fan, and worked by horse-gear or hand-power.

I have very imperfectly fulfilled my pleasant task of reporting progress, by passing in review before you the various powers by which our future harvests can be saved. The more obvious means of sheds, kiln-floors, hay-tedders, cylinders, endless bands, *cum multis aliis*, having been tried by myself and others during the last twenty-two years, and, for one cause or another, proving weak and imperfect, I think the best advice I can give to the farmers is to adopt a simple wrought-iron fan that will serve the double purpose of cooling his stacks, and testing the real value of hot-air for preparing or finishing his crops; to this he can afterwards add such machinery as I have last described, or the tube floor. (Very few cast-iron fans will answer this double purpose, because either the bearings or the blades get set fast by the expansion of the heat.)

To noblemen and landowners who have not found stack-cooling fully sufficient for their purposes, I think I am justified now in pointing out that men of their own class have already demonstrated the ease and certainty with which they can henceforth save themselves and their tenants from all loss.

On extensive estates, such as those of Lord Morton and Mr. Stratton, where the loss by a wet harvest is acknowledged to be £1,000, the possession of a £200 harvest-saver would save £800 of that loss, besides paying for itself in the very next wet season; without waiting to see whether ensilage answered, or whether something else "turned up." This £800 would then be available for silos or for "the something else;" and the harvest-saver, having paid its own cost, and presented them with a nice little sum for other purposes, could be kept in reserve for an especially rainy day, or passed on to do good service elsewhere. To prove that they can be thus passed on with perfect facility, I may mention that Jumbo and Alice, having saved 185 tons of hay at Reading, have since been borrowed from Lord Ashburton, by Mr. Taylor, of Compton Abdale, at a guinea-and-a-half per diem, and taken down by a traction engine to restore a large breadth of barley; which it is now doing at the rate of twenty loads a day.

Again, when Lord Ashburton lent his to the Reading authorities for £50 for the season, he borrowed for his own use a smaller one at £20, and this smaller one was again borrowed for the fag end of the season by Mr. Beale, of Chiddingstone, and has just finished its work of 150 tons. The Duke of Northumberland sent his to and from Witney for the Oxfordshire meeting; Mr. Fuller sent his to and from Cardiff for the Bath and West of England "gathering;" Colonel Buchanan sent his in like manner to Glasgow, and several others have travelled about the country in many directions, and for long distances. A landowner can thus have the satisfaction of first saving his own harvest and his tenant's harvests, thereby saving also claims for abatement of rent. He can then, if he chooses, lend it to others up to so late a time as the middle of November, and from then till next harvest it is available for restoring musty stacks to wholesome food, so as to complete the circle of the year.

One word in conclusion. The term "artificial harvesting" applied to this process has often created a prejudice against it—"artificial" suggesting to many minds artifice rather than art. To the Society of Arts I appeal to set right that wrong idea. Is it not art rather than artifice to make use of the powers of nature? When the natural heat of the summer fails us, what can be more simple than to re-

sort to the vast stores of hidden sunshine so beneficently provided for us in the days of old? The only art in the matter consists in converting our black diamonds into bright gold, and coining out of our old King Coal six millions of other Sovereigns.

DISCUSSION.

The SECRETARY read the following letter from Mr. W. F. Price, of Tibberton Court, Gloucestershire:—

MY DEAR SIR,—Absence from home will, I hope, excuse delay in answering yours of 1st inst. The fan answered very well with me in keeping down the heat of ricks put together before the hay was fit to carry. In one case, for the sake of experiment, I made a small rick of very wet grass, and this, though highly-coloured from heating, is perfectly sweet except the outsides, which are more or less mouldy. On the whole, I think the fan a most useful implement. It will save ricks from burning, will enable grass to be carried safely which could not be put together without it, and will make fair hay of grass when decidedly wet; but I would, of course, rather have the sun. Care should be taken so to construct the rick as to insure the passage of the air from outside uniformly over the whole external surface, and if the grass is wet, I think the heat of the rick should be kept higher than if only damp. I think wet or very damp grass may be safely left as high as 150°. I shall not, in future, use tubes to admit the thermometer, or if I do, they shall be small iron tubes closed with a cap to screw on outside; but I believe the best plan by far, is to insert the thermometer by screw or spear-head. I have generally observed mould along the course of the wooden tubes, and I believe the air finds its way in by the side of the tubes, and so prevents the more general percolation through the entire mass. We have something yet to learn of the management of the fan; but I believe it is and will be a success, if too much is not expected of it. I wish I could have been at your meeting, and I am sorry it is now too late for me to send you a sample of the rick made with wet grass. I sent a sample to our last show, which attracted much notice and caused much surprise.—Yours very truly,

W. F. PRICE.

Dec. 5th, 1882.

Mr. DRUCE said he had the honour to be Secretary of the Farmers' Club, and any remarks he made would be of a practical rather than a scientific nature. He was also one of the Assistant Commissioners appointed by the Government to inquire into the state of agriculture, and during the last three years he had travelled through the eastern counties in that capacity. He had thus seen the actual operation of some of the fans for sucking hot air out of ricks; and in the report he had presented, he had expressed a very favourable opinion of the value of this system to tenant farmers. Like all other things in their infancy, it was not yet perfect, but he believed that in a few years its value would be generally acknowledged. Its great advantage was, not that it converted grass directly into hay, but that it enabled the farmer to carry his grass before it was quite ready, and thus enabled him to get forward with his work. He had seen the temperature of a stack of barley reduced in 40 minutes from 140° to 80°, and the implement only cost about £10. There was besides that the expense of laying the pipes underneath the stack, and connecting the fan with it; but the pipe was mere drain pipe, and no skilled labour was required. He had not been fortunate enough to see Mr. Gibbs's machine at work, except at Reading. He did not quite understand if Mr. Gibbs intended to convey that the system of ensilage was more expensive than his own, but if so, he should like to hear it explained farther. This system of preserving green food was no new thing. His father, who was a practical farmer in Oxfordshire, tried it eight or nine years ago, and, though he was not successful with it, it might have been because he did not spend enough upon it. He simply dug a hole in dry soil, put in the grass, pressed it down, and sealed it up; and, he must say, that when opened, not a cow on the place would touch it. Whether it was owing to the peculiar geological formation of the district, he could not say; but if the pit had been concreted, or bricked up, he did not suppose the additional expense would have been very great. He fancied ensilage worth trying, and that, if successful, it would be the most economical system. At the same time, as a practical man, he very much questioned whether English farmers wanted ensilage, seeing they had an abundance of moist crops, and what they wanted was dry food.

Mr. DUNCAN asked if Mr. Gibbs contemplated drying freshly cut grass, or partially made hay.

Mr. GIBBS said, if grass were left for about twelve days on the swathe, even in bad weather, it could be dried with perfect facility, by passing it once through the machine.

Mr. DUNCAN asked the cost of drying the grass, if taken direct to the machine when cut.

Mr. GIBBS said there was no occasion to do that—it cost nothing to leave it on the field—by doing which, it withered, so as to be finished by once passing through the machine.

Mr. DUNCAN thought if green grass were cut, and left to the weather for a week, it must deteriorate.

Mr. GIBBS said there was practical proof to the contrary. A farmer who tried it found the hay was not at all deteriorated in market value. Only the previous day he had a letter from Mr. Fuller, in which he said that his grass had been left for seven days with rain upon it, but the hay was equally good with that which had not been rained upon at all; his cattle were eating it freely.

Mr. DUNCAN said his opinion was, that grass left out in the wet did deteriorate. He had made a number of experiments on the subject, and had had the grass analysed, and there was a decided falling off in the analysis after exposure to the weather. He had also dried grass in an ordinary kiln, which cost 13s. 6d. a ton, and he should like to know if Mr. Gibbs could do it cheaper than that.

Mr. CLEMENTS said it was quite true, as had been stated in the paper, that there was an immense loss to the farmers of this country from bad weather; and he also agreed that it was better for the grass to remain out a few days before being dried; there were very few days in which there were not dry intervals, and the grass had then an opportunity of partially drying. Evaporation went on at all temperatures, even from snow, and he had no doubt that the intermittent blast would be found more favourable than the continuous one. He thought the English patent-laws were in a deplorable condition, and tended to check invention; many of the patents taken out in America were the inventions of Englishmen. With regard to fermentation, when damp grass was put together, heat was produced, which set up fermentation, and the grass was spoiled, and it was a great boon to farmers to provide them with a machine which would remove this excess of heat, and thus prevent decomposition. He should advise farmers to have nothing to do with ensilage, but to try drying machines in preference.

Mr. C. D. PHILLIPS (Newport) said he was one of the competitors in the trial of fans at Reading, and though he was beaten, he was quite satisfied with the result. He was not only a fan-maker, but a practical farmer, and on 200 acres which he held under Lord Tredegar, he had spent nearly £6,000 in two years in experiments. The great benefit of the harvest-fan was that it enabled you to carry a crop before it was quite ready. He had a second crop of clover which was nothing like fit to carry, but the glass was going down, and there was every appearance of rain; he had carried it, and tried the fan on it with perfect success, and in two hours after the rick was up it began to rain, and rained for a fortnight, so that the clover would have been lost altogether. He had just concluded the purchase of a patent for making grass into cake. The grass was cut with a mowing-machine, then hauled and cut up with a kind of chaff-cutter; it was then put into moulds just the same as linseed cake; and by this process, the waste of any kind of food product was entirely avoided. The product was easy of transport, and would, therefore, be very useful for forage for an army, for feeding cattle on board ship, or for large towns.

The CHAIRMAN said he supposed the cakes were dried, so that after all it resolved itself into a process of drying.

Mr. PHILLIPS said the grass, when put into the moulds, was submitted to hydraulic pressure. Of course, this introduced the question of expense, and he did not know that small farmers could go in for it; but it prevented all danger from bad weather.

The CHAIRMAN said one difficulty which presented itself to his mind was, that if the grass or green produce were very succulent, the hydraulic pressure would drive out the juice; and, on the other hand, if that were to be prevented, it must be partially dried first. Green food, which contained at least 80 per cent. of moisture, must have that reduced to at least 12 or 15 per cent., or it would soon become mouldy.

Mr. PHILLIPS said the moulds in which it would be pressed would have to be heated, and the cakes afterwards further dried in a hot room. He had samples of cake made in this way in 1879, 1880, and 1881, and when broken open now, it had exactly the aroma of a field of new mown hay.

Mr. BLOOMFIELD said this last invention deeply interested him, as an Irishman, because, for many years, he had been endeavouring to raise the status of his poor countrymen, amongst other ways, by preparing dried peat, but the difficulty which had always stood in the way was, the removal of the water without spoiling the material. If Mr. Phillips's statements were correct, he seemed to have solved the problem, and the invention would be of incalculable value to Ireland.

Mr. LIGGINS said he was a practical farmer in the West Indies, where the conditions were very different, but he could give some account of the result of hydraulic machinery, devised by Sir Henry Bessemer, for crushing sugar cane. It did its work perfectly, in fact too well, for it squeezed out the juice of the outside of the stalk, as well as the sugar, but besides that, it was so slow in operation, that it was practically a failure. He would suggest that the centrifugal machine used for drying sugar, similar to that employed in large laundries, might, if made larger, be useful in drying grass.

The CHAIRMAN, in proposing a vote of thanks to Mr. Gibbs, said he would make a remark or two on the various processes suggested for preserving vegetable food, which contained eighty or ninety per cent. and upwards, of moisture. The question was how to get rid of this excess of moisture in the most economical manner. In great measure this must depend on the character of the material to be dealt with, and any experience derived from drying sugar did not appear to him applicable to the case of green foods. In his judgment, Mr. Gibbs's method of drying grass had the advantage of being in accordance with strictly scientific principles; not that he could unconditionally recommend it, because, after all, the question was one of £ s. d., and on that point he was not in a position to speak. He only knew that by this process all that was good and useful in the grass was preserved, and there was no waste of

material such as occurred when grass was left on the ground in wet weather for days together; for, with all deference to Mr. Gibbs, he must say that, in his opinion, grass certainly did deteriorate by lying on the ground. But this necessary loss would be to a great extent mitigated if farmers would not toss it about at the first gleam of sunshine, but leave it unbroken, so as to preserve as much as possible of the vitality of the grass. No doubt one cause of the success which Mr. Gibbs had mentioned was, that he was a good practical farmer, who was not in too great a hurry, but left the grass untouched on the ground. By Mr. Gibbs's plan, nothing was lost except moisture; the sugar, all the soluble extractive matters, and the albuminous compounds were preserved, and the process was rapid. How it stood with regard to expense, he could not say, but it was certainly in accordance with the true scientific principles, which was to keep the grass as far as possible in its natural condition. A good deal of nonsense was talked about fermentation. The best hay was made by allowing no loss at all by fermentation, making it rapidly, and, in that respect, a good deal must be said in favour of Mr. Gibbs's method of drying with hot air instead of sunshine. When fermentation took place, and heat was set up in the stack, it could only be generated at the expense of, perhaps, the most useful constituent of the grass, the sugar; and, in estimating the expense of drying by artificial heat, you must set off the saving of sugar in generating heat, which was a much more valuable material than coal or coke. They had heard a great deal during the last few years about the distress which had prevailed among the agricultural community, and they all had great sympathy with the suffering farmers; but after all, he held the trials they had undergone would result in some good. Farmers were a very liberal race of men, and in good seasons, when they did fairly well, they did not trouble themselves, like merchants, whether they might not have done still better; and they did not know the actual loss which they sustained with their hay-crops in wet seasons. Notwithstanding all that had been said about ensilage, they could not judge of the advantage or disadvantage of this mode of preserving food, for the simple reason that there was not a single experiment on record in which it was clearly stated what the food weighed when put into the silo, and what it weighed when taken out. It was quite possible that, weight for weight, ensilage might be more valuable than a ton of green produce, but you had to consider how much green food was put into the silo for every ton of ensilage taken out. No doubt various systems of drying and preserving food had their merits and demerits, and he might therefore say something in favour of ensilage, especially as he had been looked upon in some quarters as having set his face dead against it. He was familiar with the system almost from his childhood, under the name of *sauer-kraut*, which was really ensilage under another name, and on a small scale. It was very useful in some places to have a substitute for green vegetables in the winter, even if not quite so good, and ensilage was only *sauer-kraut* made on a large scale. In some countries, as in America and in some parts of France, where maize or similar succulent food could be grown with advantage, it was a proper thing. It had also been pointed out that, in the north of Scotland, oats did not ripen until the middle or end of October, and produced very poor grain. If in such localities they were cut green, at the time when the grain was set and still milky, and in this condition cut and put into silos, it would constitute a valuable food for winter. The fan would also be very useful in making hay; but no one should attempt to make it from wet grass. He had looked forward to the Reading trials with great pleasure, and anticipated seeing something useful, because he had seen Neilson's fans used in various parts of the country with great advantage, but he must confess, that after the third day, he lost all interest in the matter. He did not know whether, as an officer of the society, he ought to make the remarks, but he could not help expressing the opinion, that perhaps the society were in too great a hurry, and did not properly appreciate the difficulties they had to contend with. The judges were grievously disappointed by the excessively wet weather which prevailed while the trials were being conducted, and perhaps it would have been better if they had been deferred altogether to a more favourable season. It seemed unreasonable to him for anyone to attempt to make hay from newly-cut grass in wet weather. You could not drive out the moisture, which constitutes three-fourths of the bulk of green produce, by a fan arrangement. Fans were useful in keeping down the temperature in hay-stacks and checking fermentation, which was always attended with loss of sugar, the most valuable constituent of the grass; but it was impossible to keep down the temperature efficiently by fans when the grass was put in too fresh and wet a condition into stacks.

Mr. Gibbs, in reply, said he had tried the centrifugal machine on wet grass, and it did not answer. Only that morning he had a letter from a West India planter, asking if he could supply him with a machine, showing that the centrifugal apparatus was not applicable for his purpose. He thanked the meeting for the attention given to the paper, and hoped the discussion would prove beneficial.

Miscellaneous.

REPORTS ON THE EXAMINATION OF THAMES WATER.

It will add to a clear understanding, in following the reports on the examination of Thames water, to forestall a statement respecting the results towards

which "examination" is now directed, since it is only after reading through the special reports between 1828 and 1874, and the continuous reports to the Registrar-General since 1857, and the many others incorporated in the reports of the Water Examiner since 1873, that it becomes apparent what are the points which are held to be the most important to determine. It is now considered that the most important calculation that has to be made is the amount of organic matter, of animal origin, present in the water. Most of the early analyses of waters, even after the foundation of the Chemical Society in 1841, are those of natural "mineral waters," and the organic matter is generally considered to be sufficiently accurately determined by reference to "a trace." When the Thames water was first officially analysed by Dr. Bostock, and by Dr. Lamb for the Royal Commission of 1827,* the former dismisses organic matter with this remark:—"The remainder" (after the saline matters, in a residue have been calculated) "may be considered as consisting of animal and vegetable remains." Dr. Lamb, however, though not seeing how to do more than Dr. Bostock did, has recorded his own, and probably other, chemical opinions in this form:—"It appears to be acknowledged that, in the examination of the properties of a water applied to dietetic uses, the principal object of enquiry should be whether the water, being impregnated with organic matter in a state of decomposition, this matter may be either of vegetable or animal origin; but I do not know that we possess any criterion to determine, with absolute certainty, whether matter, which may be discovered, and which is decidedly of organic origin, was derived originally from one or the other of these species." This, the first recorded recognition of the importance, though written fifty-five years ago, might equally well have been written this year only. The "absolute certainty" is a degree of certainty now, of necessity, from the refinement of modern appliances, very different from what it was then, but the very improvements in methods and manufacture of apparatus and manipulative accuracy have shown the uncertainties of progressive expected certainties, and the "absolute certainty" is not yet reached. One of the greatest points of interest in tracing the history of water analysis is the development of the methods for attempting to determine the amount of orgainc matter in a water, and more recently the attempts to determine whether what is present is of animal or vegetable origin. And this, too, is of interest to observe the lapse of time that has occurred between the recognition of the need of certain determinations of detail, and the invention of a method for making them.

The need for such determinations has come to be shown from a combination of pathological, œtiological, and statistical inquiry, and has now probably a very different significance from what it had for Dr. Lamb.

Forty years later, the same view that Dr. Lamb had was, in "Watt's Dictionary of Chemistry" (1868), expressed:—"The presence of dissolved organic substance in water has, probably, a much greater influence in determining its fitness for dietetic purposes, &c."

Ten years later still, Dr. Tidy, in a paper read before the Chemical Society (1878), on "The Processes for Determining the Organic Purity of Potable Waters," wrote:—"Without stating definitely that I should be justified in expressing numerically the ratio of animal to vegetable matter by this means, I am not without hopes I shall be able to do so before long with considerable accuracy." Many other analyists have expressed the same opinion of uncertainty with regard to different process, and no one claims "absolute certainty."

It will be convenient to first state what the reports are, and how and when they have appeared.

Leaving for the present the consideration of the steps which had led up to the examination of the waters of the London companies by order of Act of Parliament, the facts immediately connected with it are these:—

The Metropolis Water Act (1852)* had included the following clause, which was the first attempt at legislation with regard to the quality of water the companies should supply (Clause 4): "From and after the thirty-first day of December, one thousand eight hundred and fifty-four, every company shall effectually filter all water supplied by them within the metropolis for domestic use, before the same shall pass into the pipes for distribution, excepting any water which may be pumped from wells into a covered reservoir or aqueduct without exposure to the atmosphere, and shall not be afterwards mixed with unfiltered water." The enforcement of this (together with the enforcement as to quantity) depended upon Clause 9, which provided, "If at any time complaint as to the quantity or quality of the water supplied by any company be made to the Board of Trade by memorial in writing signed by not less than twenty inhabitant householders . . . &c., it shall be lawful for the Board of Trade . . . to appoint a competent person to inquire into and concerning the grounds of such complaint, &c." Clauses 12 and 13 provide that if the complaint shall appear well founded, the company shall remove the grounds of such complaint under penalty (Clause 16) of £200. with £100 a month in case of delays.

[The *Journal* of September 8 last, p. 971, under "London Water Supply," contains a notice of the early filter beds of the companies, and statistics as to their development.]

The two sets of investigations made for the Board

* Royal Commission, 1827 [Roget, Brand and Telford], on quality and salubrity of water supplied to the metropolis. Report dated April 21st, 1828.

* 15 & 16 Vict., c. 84. "An Act to make better provision respecting the Supply of Water to the Metropolis;" short title, "Metropolis Water Act, 1852."

of Health in 1856 were to ascertain how far the regulaations of the Act had been carried out. The Act, it appears, did not have the desired effect. No definition was given of what "effectually filter" should mean, it is true; but still the water continued to be supplied was often pronounced by Professor Frankland, in his monthly reports to the Registrar-General, unfit for domestic use. In Prof. Frankland's annual report for 1870, it is reported that the condition of the water is such as to "almost lead to the conclusion that Clause 4 had been repealed."

A change as to power of examination was made by the Metropolis Water Act, 1871, by which the examination was not left dependent on the complaint of twenty householders. Clause 35 of that Act, provided that the Board of Trade may, at any time, if, and when they think fit, appoint a competent person to inquire into and report on the quality of the water furnished by any company, notwithstanding that no complaint, &c. [Notice that quantity was not included, and quality was taken to mean more than merely "efficiently filtered."] Clause 36 provides, "There shall be a water examiner . . . . . who shall from time to time, in such manner as the Board of Trade direct, examine the water supplied by any company, in order to ascertain whether or not the company have complied with the requirements of Section IV. of the Metropolis Water Act, 1852, &c., and shall from time to time report, &c.* It will be noticed that Clause 36 applies to examining, with reference to "effectual filtration," while Clause 35 provides vaguely for examination of "quality." It is not apparent, whether two officers were intended, whether by "quality," chemical quality was meant, or only quality as regards absence of such suspended matters as efficient filtration should remove. As a matter of practice, "the water examiner," Colonel Bolton, reports on the filter beds and on whether water is clear or turbid after filtration, while Prof. Frankland, who reports on the chemical analysis of the waters, also reports on the efficiency of filtration. In the Session of 1882, it was resolved to transfer the power conferred upon the Board of Trade to the Local Government Board. [On Prof. Frankland's reports see below, under reports to Registrar-General.]

The Reports of the Water Examiner.

The monthly report is given in a tabulated form, in a single sheet, which, since the enlargement in 1873, is about 25 in. by 20 in.

The annual reports are to be found in Parliamentary Papers, as appendices in Local Government Board Reports.

Colonel Bolton's reports, therefore, contain the official account of the examinations made, to ascertain how far the requirements of Clause 4, of the Act of 1852, have been carried out. They also show how far the constant supply provisions of the Act of 1871 have been adopted. They rest on totally different ground. The requirements of "efficient filtration," whatever that may mean, are imperative. Those of "constant supply" depend upon the proportion of houses in a district, which adopt the fittings suitable for the pressure of a constant supply (see Sec. 10, Act of 1871). Constant supply has been referred to in a previous notice. In addition to the official report, which Colonel Bolton gives, a number of other matters are referred to in his monthly reports.* For example, in his 1876 report, he states the duties of "water examiner," omitting, however, but without explanation why, all reference to the duties as to reporting on constant supply; and then continues: "In addition to inspecting the filter beds and reservoirs, and examining the quality of the water both at the intake and after filtrations at the works, I have included in my reports the following information and particulars, &c., &c." Where an Act of Parliament is not explicit, there is always latitude allowed to those who have the practical interpretation of it. The information given, "in addition," is valuable; but there are obvious reasons for drawing a distinction between what is reported as important by the consensus of Parliamentary opinion, and what is reported on individual opinion as of importance. Most competent judges will agree, that much of the information, so given, should be given as a report in accordance with some clause in an Act; but, for the present, that distinction must be drawn.

With regard to the expression, "efficient filtration," and in the absence of any definition, Colonel Bolton writes: "Efficient filtration depends upon:—

1. A sufficient area of properly constructed filter-beds, constantly cleaned, and fresh sanded.
2. The rate of filtration being controlled and limited to a certain speed.
3. The water delivered into the filter.beds having been previously stored on subsidiary reservoirs, and the capacity of these reservoirs being such as to avoid the intake of turbid and muddy water during the time of extraordinary floods, which tend to foul and choke the filters.

The manner of reporting on the efficiency of filtration, is to state whether the samples of water examined are clear—slightly turbid—turbid—or very turbed. Nowhere, however, is there any explanation given as to what is the standard or the scale followed.

(To be continued.)

* Strange as it may appear to some, the official channel for the reports, was the under secretary of the Railway Department, Board of Trade.

* As a matter of fact, the monthly reports, though referred to in the annual reports, have been apparently nowhere preserved, unless by some unknown collector.

Correspondence.

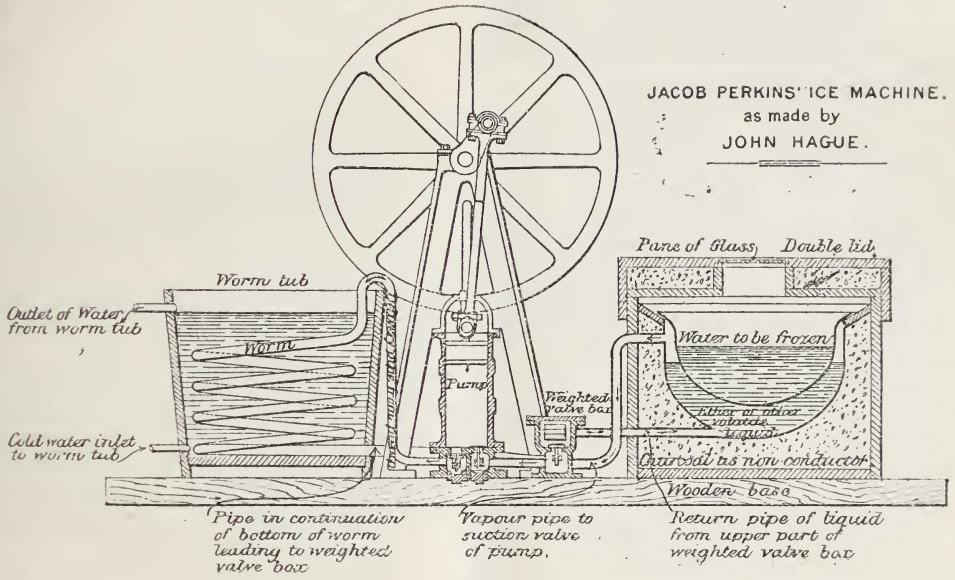
ICE-MAKING.

I regret I was not able to be present at the reading of Dr. Hopkinson's very interesting paper on

Wednesday, Nov. 21st, on this subject, which paper, however, I have since seen in the *Journal*.

It has occurred to me that it may interest those connected with ice-making, if I were to recall to public attention the invention (patented in 1834, No. 6,662) of Mr. Jacob Perkins, the grandfather of our present Member of Council. A reference to this specification (if anyone could get a copy of it, for it, like many others, is out of print) would show that Mr. Perkins claimed to have invented, not the freezing of water, or cooling of bodies by the evaporation of ether or other volatile liquid, but—the essential thing for commercial purpose—the "apparatus or means, as above described, whereby I am enabled to use volatile fluids for the purpose of producing the cooling or freezing of fluids, and yet, at the same time, constantly condensing such volatile fluids, and bringing them again and again into operation, without waste."

A small machine of this kind was made for Mr. Perkins, by Mr. John Hague, the engineer, and Mr. T. R. Crampton (now, like Mr. Loftus Perkins, a member of your Council), and myself, who were apprentices at that time to Mr. Hague, assisted in its manufacture. It was intended to use sulphuric ether in the machine, but as a matter of fact, it was put to work with the volatile liquid arising from the destructive distillation of caoutchouc, and it succeeded in producing ice, and in doing so in the height of summer. The apparatus was a small one, carried on a wooden base—according to my recollection, some five feet long by two feet or two feet six inches wide. At one end there was a jacketed copper pan, the interior of



which held the water to be frozen, while in the jacket was the volatile liquid and its vapour. The pan was enclosed in a wooden box, containing powdered charcoal as a non-conductor. From the top of the jacket a pipe was lead away to the suction valve of an air-pump, fixed in the middle of the wooden base. From the delivery valve of this pump a pipe proceeded to the top of a worm, contained in a worm-tub, supported on the wooden base, at the end opposite to that where the jacketed pan was. The worm-tub was supplied with water, from an inlet at the bottom, and the escape was by an overflow at the top. A pipe, in continuation of the lower end of the worm, was connected to the underside of a valve box, in which was a valve loaded to about 15 lbs. to the inch, so that the vapour in the worm was subjected to this pressure, as well as to the cooling influence of the water, and by these means was brought back to a liquid condition. From the upper side of the valve box a pipe proceeded to the bottom of the jacketed pan, to convey the liquor to it, thus completing the circuit.

I send a rough sketch of the apparatus above described, and I also send a tracing of the drawing of Perkins's specification, and a manuscript copy of the specification itself, in order that you may see how closely a practical working machine agreed with the drawing of the specification, the only difference in truth, being that, had the machine been made exactly in accordance with the specification drawing, the block of ice must have been sawn asunder before it could have been removed.

FREDERICK BRAMWELL.

General Notes.

INSTITUTE OF PATENT AGENTS.—A notice of the incorporation of this institute was given in the number of the *Journal* for September 22 (vol. xxx, p. 1014). The Inaugural Meeting was held on Wednesday, November 29th, when the President, Mr. J. H. Johnson, delivered his address.

ELECTRICAL EXHIBITION AT VIENNA.—An international exhibition of appliances connected with electricity is to be held in the buildings of the 1873 Exhibition, Vienna, from August to October, next year. Application for space must be made to the Committee of Direction, before 1st January next. No prizes are offered, and no charge will be made for space, or for motive power for the general display; but motive power for individual exhibits and demonstrations must be paid for at the rate of fourpence per horse power per hour. Protection will be accorded to non-patented articles until the end of the year.

MEETINGS OF THE SOCIETY.

Friday evening at Eight o'clock :—

DECEMBER 13.—"Electrical Exhibitions." By W. H. PREECE, F.R.S. WILLIAM SPOTTISWOODE, LL.D., D.C.L., P.R.S., will preside.

DECEMBER 20.—"The Utilisation of Waste. A Quarter of a Century's Progress." By P. L. SIMMONDS.

For meetings after Christmas :—

"Some Points in the Practice of the American Patent Office." By Sir FREDERICK BRAMWELL, F.R.S.

"The Sanitary Inspection of Houses." By W. K. BURTON.

"The Modern Lathe." By J. H. EVANS.

"The History of the Pianoforte." By A. J. HIPKINS.

"Technical Aspects of Lignification." By C. F. CROSS, F.C.S.

"Self-purification of River Waters." By W. N. HARTLEY, F.R.S.E.

"The Application of Electrolysis to Bleaching and Printing." By JAMES J. DOBBIE, D.Sc., and JOHN HUTCHINSON.

"The Formation of Diastase from Grain by Moulds." By R. W. ATKINSON, B.Sc.

"Recent Improvements in Agricultural Machinery." By D. PIDGEON.

"English and Foreign Silver Work; with some Remarks on Hall Marking and its Advantages." By WILFRED CRIPPS, F.S.A.

"Overland Commercial Communication between India and China, *viâ* Assam." By CHARLES H. LEPPER.

"Agriculture in Lower Bengal; with a notice of Tenant Right, &c," By W. S. SETON-KARR.

"Private Enterprise in India." By J. M. MACLEAN.

"Some Notes on the Domestic Architecture of India." By C. PURDON CLARKE.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Silvanus Thompson, "Dynamo-Electric Machinery." (Lecture II.)
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m.
Medical, 11, Chandos-street, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. J. C. Morrison, "Thomas Carlyle."

TUESDAY, DEC. 12...Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on paper by Mr. John Daglish, "The Sinking of Two Shafts at Marsden for the Whitburn Coal Company."
Photographic, 5a, Pall-mall East, S.W., 8 p.m. Discussion on Mr. Burton's paper.
Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. A. L. Lewis, "Note on some Flint Implements and Flakes from Cape Blanc Nez (near Calais)." 2. Mr. A. W. Howitt, "The Australian Class Systems."
Science Society, King's College, Strand, W.C., 8 p.m. Mr. W. G. McMillan, "Fires, their Causes, Prevention, and Extinction."
Royal Colonial Institute, Grosvenor Gallery Library, W. Bishop of Saskatchewan, "North West Territories of Canada."

WEDNESDAY, DEC. 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. H. Preece, "Electrical Exhibitions."
Graphic, University College, W.C., 8 p.m,
Public Analysts, Burlington-house, W., 8 p.m. 1. Mr. C. T. Kingzett, "Some Analyses of Asphalte Paving." 2. Mr. J. Carter Bell, "Examination of Beers obtained from Beersellers and Brewers." 3, Dr. W. Douglas Hogg, "The Work of the Paris Municipal Laboratory."
Microscopical, King's College, W.C., 8 p.m.
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

THURSDAY, DEC. 14...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. R. S. Ball, "The Recent Transit of Venus."
Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Annual General Meeting. Mr. Thomas J. Larkin," "The Application and Extension of Telephonic Communication in Japan."
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.
Mathematical, 22, Albemarle-street, W. 8 p.m. 1. Prof. H. Lamb, "The Vibrations of a Spherical Shell." 2. Paper by Prof. H. Smith. 3. Mr. E. B. Elliott, "Certain Relations between Volumes of Loci of Connected Points." 4. Mr. J. J. Walker, "Geometrical Proof of Griffiths' Extension of Graves's Theorem."
Society of Engineers, 6, Westminster-chambers, S.W., 7½ p.m. Mr. Henry Adams, "Strains in Ironwork." (Lecture II.)

Journal of the Society of Arts.

No. 1,569. Vol. XXX.

FRIDAY, DECEMBER 15, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

The usual short course of lectures, adapted for a juvenile audience, will be given on Wednesday evenings, January 3rd and 10th, by Professor Henry Nottidge Moseley, M.A., F.R.S., on the "Inhabitants of the Ocean." The lectures will commence at seven o'clock. As in former years, admission will be by ticket only, and no member can be admitted without a ticket. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and one adult. Members who require tickets should apply at once.

LABELS FOR PLANTS.

The Council of the Society of Arts offer a Prize of Five Guineas, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for a Wooden Plant Label, saturated with paraffin, or some other preparation which would preserve the label, and would be likely to keep the writing upon it legible, either with or without the aid of paint, for five years. The labels will be tested by the Committee with the view of ascertaining, as far as can be done in a limited time, whether they would be likely to stand prolonged use. It is believed that satisfactory tests can be made in a month or two.

An additional prize or five guineas has been placed at the disposal of the Council of the Society by Mr. E. G. Loder, for the best permanent border label suitable for private gardens, the cost of which should not exceed £4 per thousand.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society not later than the 1st June, 1883.

Both awards will be made on the recommendation of the Committee appointed for the purpose by the Council.

The Council reserve to themselves the right of withholding the prizes offered if, in the opinion of the judges, none of the specimens sent in are deserving.

CANTOR LECTURES.

The second Lecture of the First Course on "Dynamo-Electric Machinery," was delivered by Professor Silvanus P. Thompson, D.Sc., on Monday evening, the 11th inst. The subject of this lecture was the dynamo in practice. The following machines, models, &c., were lent for the illustration of the lecture:—Two Brush machines, lent by the Brush Company; a Gramme machine, by the British Electric Light Company; a Siemens machine, by Messrs. Siemens Bros.; an Edison machine, by the Edison Company; a Pacinotti machine, by Mr. Sennett; the armature of a Bürgin machine, by Messrs. R. E. Crompton and Co.; a Gülcher machine, by the Gülcher Electric Light and Power Company; a model of Mr. C. F. Varley's, made about 1860; a model of Mr. Ladd's original machine.

NEW MEMBER OF COUNCIL.

At the last meeting of Council, Professor F. A. Abel, C.B., F.R.S., was elected a member of Council in the room of the late Right Hon. Lord Otho Fitzgerald, who died on the 19th of November last.

Proceedings of the Society.

FIFTH ORDINARY MEETING.

Wednesday, December 13, 1882; William Spottiswoode, LL.D., P.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Allan, Alexander, Netley-court, near Southampton.
Cooke, Major-General Anthony Charles, C.B., Ordnance-house, Southampton.
Goodman, Henry Martin, Avalon, Catford Hill, Catford, Kent.
Harris, John, Clifton-house, Kilburn-square, N.W.
Joel, Henry Francis, 44, Lavendar-grove, Dalston, E.
Liberty, Arthur Lasenby, 7, Fairfax-road, Finchley-road, N.W.
Perks, Robert William, Calverley, Chislehurst, and 147, Leadenhall-street, E.C.
Turner, H., 51, Bury New-road, Manchester.

The following candidates were balloted for and duly elected members of the Society:—

Ash, William Henry, Porthcurno, Penzance.
Carr, Lieut. George Anderson, R.E., Brompton Barracks, Chatham.
Focking, A., 15, Bayswater-terrace, Bayswater, W.
Gordon, Joseph, Reform Club, S.W.
Gribble, Charles Risdon, 6, Adam-street, Adelphi, W.C.
Laing, David, 2, Duke-street, Adelphi, W.C.
Sharples, C. H., F.C.S., 21, Latham-street, Preston.
Shearman, Henry Franklin, 15, Linden-gardens, W.
Siemens, Alexander, 12, Queen Anne's-gate, S.W.
Tamburini, Joseph Sylvius, 1, Gray's-inn-square, W.C.

The paper read was—

ELECTRICAL EXHIBITIONS.

By W. H. Preece, F.R.S.

Exhibitions and displays of the practical applications of science to the useful wants of man, have been cropping up during recent years with marvellous rapidity and fecundity. They owe their origin chiefly to the great Loan Collection of Scientific Apparatus, which was held at South Kensington during the latter six months of 1876. This was the first real electrical exhibition. In the Great Exhibition of 1851, one of the thirty classes into which the exhibition was divided, was devoted to "Philosophical instruments, and processes depending upon their use," and a small sub-division of this class was devoted to Magnetism and Electricity. Here we had mariners' compasses, electric telegraphs—then in their infancy, the application of electro-magnetism as a motive power—still in its babyhood, the electric light—well matured even then, electric clocks, therapeutic applications, and electrotype apparatus. Here was shown the first submarine cable, Dr. Joule exhibited his great electro-magnet, and Hjorth the Dane—the foreshadower of the electro-dynamic system—showed his early attempt to obtain motive power by electro-magnetism, but the show was small, and only really interesting in the telegraphic branch; and I think it was here that the Chairman of our Council received his first public award in England, for the very fine exhibit his firm (Siemens and Halske) made, and which richly earned a Council medal. In 1851, electricity played but a very minor part. In the next Exhibition of 1862, great progress had been made, and though the same classification was adopted as in 1851, the electrical sub-division was very much larger. An extremely able report on the electrical instruments displayed was written by Professor Fleeming Jenkin. Improvement and progress were still confined to telegraphy; but, in the meantime, submarine cables had become practical and commercial undertakings. The Atlantic had been spanned, and a very strong stimulus had been given to scientific research, from a practical point of view. Sir William Thomson had brought his brilliant intellect to bear on this virgin soil, and the result had been that the Exhibition of 1862 denoted very great progress in invention and constructive skill, and displayed a numerous and excellent assortment of electrical appliances for other purposes than telegraphy. For instance, the electric light was one of the attractions of the place. Duboscq and Serrin, of Paris, Jaspar, of Liege, and Holmes, showed their arc lamps in operation. The magneto-electric machine and lamp of the last exhibitor had been working at the Dungeness Lighthouse from the previous year to the year 1875. Holmes's machine still works the South Foreland and Soutar Point lighthouses under the care and management of our excellent Trinity House. I remember very well an electric engraving machine and an electric loom at the 1862 Exhibition.

In 1871, we had another International Exhibition, chiefly associated in our memories with the loss of the founder of the great Exhibition of 1851, and our own much revered President. It was not a success, and I can find no record of the exhibition of any striking electrical novelty. It was not comparable with the Exhibitions of 1851 and 1862, and it was not followed by any such valuable report as that of Professor Fleeming Jenkin, on the Exhibition of 1862.

There were great and successful International Exhibitions held in Paris in 1867 and 1878. The latter was epoch marking, for though electricity formed but a very small subsection, it was the occasion when Jablochkoff lighted up

the Avenue de l'Opera, and produced such a consternation among gas shareholders. The Pavilion, illuminated by him, was one of the striking features of the show. Here, also, we saw the great developments made in the electro-dynamic machine by Gramme and Siemens.

At Vienna, in 1873, a very successful exhibition took place, noteworthy for being the occasion when Fontaine first showed the capital experiment of transmitting power by electricity. A gas-engine moved a dynamo-machine (the generator), which turned another dynamo-machine (the motor), 1,000 metres off, that worked a centrifugal pump.

Philadelphia, the Great Centennial Exhibition of 1876, is celebrated for Bell's great experiment of transmitting or rather reproducing speech by electricity. It was here that Sir William Thomson heard Shakespeare quoted through an ordinary telegraph wire by means of "the greatest by far of all the marvels of the electric telegraph."

There was an Industrial Exhibition in Berlin in 1879, which is interesting, from the fact that here Siemens worked the first tramway by means of electricity, carrying eighteen persons.

The first electrical exhibition was that of 1876. In the previous exhibitions, electricity played a very small subsidiary part—here it came into prominence and took the leading place. It was intended to display scientific apparatus employed for teaching and for investigation, and also such as possessed historic interest on account of the persons by whom, or the researches in which, they had been employed. It became also a very fine exhibition of the practical applications of electricity. It was international in its character, though not in its design. A very large number of exhibits were sent from abroad. It was supported by the most eminent phycisists and scientific men on the Continent. Abroad, it obtained a reputation it never reached at home. It was most unfortunate in its title. "The Special Loan Collection of Scientific Apparatus" was not attractive. The press, for some unaccountable reason, decried it. The general public shunned it, and though 213,196 people visited it, it never acquired the popularity then, which it certainly would acquire now, if it were held again, and given a more telling title. But such priceless treasures as were brought together there will never be brought together again. The catalogue and publications issued by it form a small library. There was not only an admirable catalogue—one of the best ever compiled—but a handbook of short descriptive essays, written by such men as Clerk Maxwell, Clifford, Spottiswoode, Tait, Carey Foster, Norman Lockyer, Geikie, Huxley, and others equally eminent.

There were 1,404 exhibitors, of whom 761 more than half, were foreigners, derived from the following sources :—

United Kingdom	643
Austro-Hungary	46
Belgium	18
France	116
Germany	378
Holland	33
Italy	47
Norway	9
Russia	70
Spain	14
Switzerland	30
	1,404

The number of objects exhibited was about 13,000. There was held, in its earlier days, also a conference of scientific men, at which 110 papers were read, and which brought together an average attendance of seventy persons. There were no less than fifty-three evening lectures, to which admission was free, and at which the average attendance was 425. At these conferences and lectures explanations and demonstrations were made of the method of using and employing the various instruments exhibited. The historical portion of the exhibition was the richest of its class that has ever been held. Notwithstanding all this, the exhibition fell dead, and it is now but little remembered. It came before its time.

The Electrical Exhibition of Paris, of 1881, was more fortunate. Owing to the excitement consequent on the activity of electric light promoters, and of the startling invention of the telephone, the public had become interested in electricity. The title, "electrical exhibition," was attractive, and the energy and enterprise of M. Cochery, the Minister of Posts and Telegraphs, brought together very strong support from other nations. Hence the Paris exhibition became, in every sense of the word, an "international electrical exhibition." Here we saw every nation vying with each other, to see how the electric current could, economically, supplant gas as a domestic illuminant. Here we saw, for the first time, Edison's solution of the problem, and the progress made by his great English rival, Swan. Here we saw Duboscq, Serrin, Jaspar, and Siemens, with their experiences since 1851, indicating the

progress they had made during the past thirty years. Again, we saw telegraphs moulded by experience, invention, and practice into fine race-horses, compared to the heavy dray-horses of the former period. In 1851, it was scarcely possible to send twenty words a minute; here we saw 200 words a minute transmitted, as a matter of course. Only one message could be sent on one wire in 1851; in 1882, two, four, six, and eight messages were shown in transit simultaneously, on one wire. The telephone had sprung into existence. Music was transmitted from the opera, and the words spoken on the stage were distinctly heard a mile or more away. Boats were propelled by electricity upon a small lake, and ploughs were moved, printing machines worked, balloons gyrated about in the air, sewing machines rotated by currents of electricity, produced a long way off. Here again, we saw how electricity can be employed to give instant warning of fire, and by-the-by, how few there are who avail themselves of this useful and valuable application. Not only can we, by merely touching a button, raise an alarm of fire in the police-station or in the fire-engine station, but we can make the fire itself, in its early stages, automatically raise an alarm, and practically say, "Here I am burning away nicely and merrily in the library, will nobody come and put me out." In the face of the terrible fire that London witnessed last week, it is hoped that some attention will be given to this most beautiful application of electricity, which was so fully shown in Paris and subsequent exhibitions.

The Paris Exhibition produced no striking novelty. It illustrated rather progress. New methods, new combinations, new applications were numerous, but absolute novelties were absent. It, however, showed the practical man to be a head of the philosopher, and illustrated the fact, that in the case of electricity, the science owes more to practice than to theory. Unlike the exhibition of 1876, the press, especially the *Times*, met the want of the public, by publishing very full and able reports of the work done and descriptions of the things shown. The exhibition was also the occasion of the meeting of a very important congress of electricians of all countries, at which numerous questions were discussed, but at which the most important was the establishment of a uniform system of electrical measurements. In this field of measurement there was no deep-seated *inch* to brush aside, nor time-honoured *shilling* to drive into oblivion, but the coast was comparatively clear. The quantities to be measured were little known, few had been working on the question, and therefore the difficulties to surmount were not many. The necessity, however, for a uniform system of standards, and a universal system of nomenclature was paramount, and hence a coherent system was proposed, accepted, and universally adopted with wonderful celerity. This speedy adoption was the most striking proof of its necessity. Men wanted to know how much electricity they were using to produce given effects, how much electricity was the result of certain mechanical operations, how much electricity could be conveyed to a given distance by a given wire. Moreover, as electricty was the result of mechanical motion, it was clear that there must be an intimate connection between motion and electricity. And as all motion involves *time* and *space*, and mechanical motion *matter* also, so electrical measurements must be based on mechanical ones. Hence the centimetre as the unit of space, the gramme as the unit of mass, and the second as the unit of time, have been taken as standards, and the system is therefore called the CGS system of units. Now we have in electricity, *electromotive force*, that determines its flow; *resistance*, that opposes this flow; and *current*, the flow itself. But electricity can also be stored up in a kind of caged condition, ready to burst out into lightning, or to flow out gently, "to waft a sigh from Indus to the Pole." It is then held prisoner by induction, the magnitude of which is measured and expressed by the term *capacity*. Now, a unit of electricity is called a *coulomb*, and if this unit, under the influence of a unit electromotive force, flows for one second through unit resistance, it produces a current of one *ampère*. The standard resistance is called an *ohm*, while the standard electromotive force producing the flow is called a *volt*. If this coulomb so produced were stored by induction, then the capacity of the configuration maintaining it would be called a *farad*. The capacity of a conductor is thus measured by the quantity of electricity it will hold, as a cask is measured by the quantity of wine it holds.

The ohm can be represented by a column of mercury 1·0615 metres long of a square millimetre section at 0° Centigrade.

The volt is very nearly the electromotive force of a Daniell cell.

An ampère is very nearly the current

required to maintain an 18-candle glow* lamp alight.

A farad is too large for practical purposes. So we take a millionth part of it, and call it a *microfarad*, which is the capacity of about three miles of an Atlantic cable.

Some idea of the quantity of electricity involved in electric lighting, may be gathered from the fact, that it would require 3,000,000 miles of the Atlantic cable—an area of seventeen and a-half square miles—to hold the quantity of electricity that passes through each lamp in this room each second of time. It is comparable to the charge contained in a thunder cloud before it bursts out in lightning. For a cloud offering three square miles area at a moderate height—say 100 feet—the charge would not be more than one coulomb.

Now, when electricity flows through resistance, it does work upon the matter through which it flows. Hence heat is produced, and hence glow. Now, this work done, depends upon the current flowing and on the electromotive force present. If we multiply the electromotive force by the current, we have a measure of the energy expended. Hence one volt × one ampère = one watt, which is the unit of electrical work. Seven hundred and forty-six watts equal 1-horse power; so that we have a very ready means of converting the expression for electrical energy into that of mechanical power, and *vice versa*. Each glow lamp in this room is worked by 105 volts, and ·8 ampère, or it requires an absorption of 84·0 watts, something less than one tenth of a horse power per lamp. Now all these units, except the watt, were chosen by the Electrical Congress at Paris, in 1881, and they have been accepted by all the world. This is the great result of the Paris Exhibition, and that which will mark it as an epoch in the history of electricity.

The success of the Paris Exhibition led to an imitation of it at the Crystal Palace in the early part of the year. As a practical and popular exhibition, the result was undoubtedly a success; but it was mainly a commercial undertaking, and could not in any real sense be called international. It followed the Paris Exhibition too quickly. There was a very fair display of electrical appliances; over 300 exhibitors sent things there; but it was chiefly as an electric light exhibition that it will be remembered. Telegraph instruments and bells, telephones, and cable grapplers, were mixed up too much with toys, weighing machines, and toilet commodities, to give it a scientific character. As a practical demonstration of electric lighting, it left nothing to be desired, but as an event marking scientific progress, it must soon be forgotten. A new exhibition, in which gas plays a prominent feature, opens there to-day, with what prospect of success I cannot say.

A very interesting exhibition of quite a different character took place in September and October last, in Munich. Though it was called international, it was purely German. There were only 170 exhibitors but what was shown was good. The principal object aimed at, was to display in the very best artistic manner, the power of electricity to illuminate space, and this was done with very great success. In the centre of the building an exceedingly handsome fountain, brilliantly lit up by coloured rays, played in the centre of a pretty garden, laid out with great taste and care.

Here we saw a quaint representation of the past and present. The past—an old hut or cottage, furnished with the oldest and blackest oak, a plain and simple table and stool, a spinning wheel, a crucifix, an iron clock, lit up by an old greasy oil lamp. The present—a well-arranged library of the present day, fitted up with the most expensive and artistic furniture, and all that luxury, wealth, and taste could command, beautifully illuminated by glow lamps.

In the nave there was a copy of an old Norman church, fitted up inside with all the appurtenances of a church, a lay figure kneeling before a lectern, with all the gorgeous robes of a high dignitary of the church of Rome, and upon whom was playing the brilliant rays of an arc lamp. The effect was picturesque and striking.

There was also a theatre, capable of holding 300 people, fitted with a stage, footlights, set scenes, &c., in which, every evening, pantomimic representations took place to show how electricity was adaptable for stage effects. There was also a picture gallery so illuminated. The chief feature at the exhibition was the transmission of power from the falls of the Iser at Hirschau, 5 kilometres off, to the building, and also from Miesbach, 57 kilometres (34 miles) off. The latter experiment was made by Marcel Deprez. Two wires were used, and half a horse power was obtained. The

* I accept this term "glow," proposed by Dr. Siemens. Glow lamps are sometimes called "incandescent," sometimes "incandescence;" the latter is the more correct, but the less euphonious. Glow is equally correct, far more euphonious, and more in accordance with the spirit of the age.

experiment was the same as though a waterfall at Bath worked a circular saw in this room.

There was a new lamp shown about which which we may hear something further. It is the invention of a Signor Cruto, an Italian, who for 12 years has devoted his time to discovering a mode of constructing artificial diamonds, and has ended by producing a glow lamp! The lamp consists of a *tube* of carbon and requires only half an ampère to work it, a result which, if carried out, will be of immense economy and importance. The production of the electric light has already been brought well into economical comparison with gas, and it only wants two or three inventions of this kind to make it much cheaper than gas. Dr. Siemens considers it the light of the rich, but if the progress of the past two years is maintained, it will become ere long the light of the poor as well.

Among the curiosities exhibited there, I was able to secure only one. It is an instructive and amusing series of photographs, taken by Dr. von Zeemssen—a celebrated electro-physiologist of Munich—of the face of the same person who has, involuntarily, been compelled to assume expressions of various emotions by the application of currents of electricity to various muscular nerves of the face.

The Munich Exhibition will be chiefly distinguished by the careful electric tests that have been made there by a very distinguished jury, aided by very perfect apparatus, and a splendid laboratory. The results are not yet published. They are looked forward to with much interest, for they are certain to be valuable, and worthy of every confidence.

It will be gathered, from what I have said, that the chief peculiarities of the past exhibitions are these:—

At South Kensington, we had a magnificent collection of the scientific condition of electrical apparatus at that date—1876. At Paris we had an equally magnificent show of their practical condition, in 1881. At the Crystal Palace the commercial element stepped in, converting a picture of progress into a means of advertisement; while at Munich, science again comes in to fulfil its chief duty, to measure and compare. At Paris and the Crystal Palace medals and honours were distributed, but at Munich the far more sensible plan has been adopted of giving simple certificates of efficiency, showing plainly what each apparatus can do in its own particular sphere.

We are about to have not only a second exhibition at the Crystal Palace, but also one at the Westminster Aquarium. These are purely commercial speculations, and scarcely come within the remarks I have to make. Vienna is also to have an exhibition in the autumn, and doubtless they will be repeated in all chief cities.

What are the advantages of these electrical exhibitions? They undoubtedly denote progress, and they instil and spread knowledge. They enable the public to see with their own eyes what is being done in special fields of manufacture and enterprise. They are useful in bringing to the notice of the many what is, perhaps, only known to the few; but good wine needs no brush, and a good thing soon finds its way into notoriety without the necessity of an exhibition. For instance, Clarke's gas-lighting apparatus has not, to my knowledge, been shown at any exhibition, and yet its consumption is so great that, I am told, the manufacturers can scarcely cope with the demands. They excite emulation among inventors and manufacturers, and they strike out new paths for inquiry and appreciation. There was a striking exemplification of this at the Crystal Palace. Messrs. Verity, of King-street, Covent-garden, showed an extremely artistic and elegant mode of fitting up glow lamps—a mode which distinguished the Edison exhibit from all others. This fired up all rivals, and before the exhibition was over, we had a display from Swan and Brush which rivalled, if it did not surpass, the pioneer.

International exhibitions bring foreign countries into more intimate unison, and nothing can be happier or more conducive to progress than the prevailing relations established by such a gathering at Paris.

When well matured and properly carried out, they not only respond to the public pulse, but they supply a decided want; when ill-matured and injudiciously inaugurated, they tend to retard progress by compelling abstentions, and by descending to mere gigantic advertisments. As it was, both at Paris, the Crystal Palace, and Munich, many held aloof. At Paris, England made but a sorry show compared to what she could have done; while at Munich, England, France, and North Germany were conspicuous by their absence.

There can be no doubt that progress is expedited by such exhibitions as that of South Kensington and of Paris. The Exhibition of 1851 gave an impulse to English art that has progressed by accelerating energy, and Paris has given a fillip to electric lighting that

nothing will stop—not even the financial eccentricities that have characterised the mania of this year.

On the other hand, it is a question how far this mania is attributable to those exhibitions. A little knowledge is a dangerous thing, and a little knowledge of electricity with a fair insight into financial bubbling, has done what electricity cannot do—it has transferred gold from the coffers of the too confiding to the pockets of the too speculating. The rush of the public into these electrical appliances has appalled the initiated. Electric lighting is still in a tentative stage, but it is progressing with great rapidity. It has been shown to be practical, but it has not yet been proved to be economical. No one can say how far or how much it will be used, nor what are the best conditions for its installation, and while it is in this infantile state, it is difficult to understand the action of so many local corporations, whose chief desire appears, in many instances, to strangle the bantling, rather than to encourage its growth. In the meantime the real, sound, commercial undertakings are checked in their progress, while the loud roaring speculator and wide-mouthed promoter have not yet been driven off the road.

Electrical exhibitions, when international, teach the lesson how ignorant we are of each others actions and progress. They give an enormous impetus to the interchange of ideas, and when carefully considered, they must have a beneficial influence on practical progress and social improvement. Hence I would urge that exhibitors should eschew as much as possible mere commercial speculations, and wait patiently for that period when a great public want will force the Government to undertake the management of a great International Electrical Exhibition in London, fostered by the experienced authorities in South Kensington, and supported by such communities as that of the Society of Telegraph eccentricites and of Electricians, and of the Society of Arts.

DISCUSSION.

The CHAIRMAN said Mr. Preece had described, with great clearness, the different kinds of exhibitions which had taken place, some recommending themselves more to the scientific mind, some to the practical improvers of the applications of electricity, and others to the public, as employers of electricity for lighting or other purposes; and he had no doubt that all these exhibitions had their use. But the great interest of any exhibition must be as representing the real progress made, or work done. He agreed with Mr. Preece in hoping that the speculative and financial phase of electric progress, which had characterised the year now drawing to a close, would shortly be replaced by a phase of practical activity. One step had been gained by the passing of the Electric Lighting Act of the last Session, and he believed the authorities of the Board of Trade were now busily at work, framing those additional details which were necessary before the Act could be put into actual operation. The progress of this application of electricity would depend very largely on the public demand for it; and he felt satisfied that it had so far passed the experimental stage, that it was capable of taking up a practical position for the benefit of the community. It was true that we did not yet know, from actual experience, what might be the economy of electric, as compared with other modes of lighting, for that could only be determined when it had been made use of on a large scale. All those who were connected with mechanical operations knew how different the application of a number of small steam-engines would be to that of one large one for carrying out any operation requiring great mechanical power; and, therefore, until machines were in use capable of producing very large results, worked by large engines, it was impossible to say what degree of economy might be attained.

Mr. J. N. SHOOLBRED said Mr. Preece had drawn particular attention to three exhibitions—the Loan Exhibition, which had fallen almost flat, the Paris Exhibition, in connection with which the Jablochkoff light had been shown in the Avenue de l'Opera, and the Paris Exhibition of 1881—but the results described were not merely due to these exhibitions. they were the outcome of about fifty years of gradual experience, commencing with Faraday's discoveries in the Royal Institution. The electric light had been working on gradually, and had taken practical form in lighthouses at Dungeness, the South Foreland, La Hogue, and elsewhere. Therefore the scientific mind had been gradually ripening; and with regard to the success which attended the labours of the International Congress of Electricians at Paris in adopting the units, that also was really the result of some fourteen or fifteen years working with those units, which had been elaborated by a Committee of the British Association, under the chairmanship of Sir William Thomson. It was the fact of this committee having worked so successfully which enabled the units so readily to acquire an international character. There was scarcely an electrician now who was not familiar with them—not because they were adopted in Paris, but from long previous experience. The exhibition at the Crystal Palace might have been of a purely commercial character, but its usefulness could hardly be doubted, considering how many people were unable to visit the Paris Exhibition, who would gladly have done so, and an opportunity wa

then given to many Corporations and Local Boards to study electric lighting, the result of which might be traced in the passing of the Act of last Session. He did not think that Act would now have been law, but for the interest awakened in the subject by the Crystal Palace Exhibition. Mr. Preece had described, in connection with the Munich Exhibition, the contrast between the past and present, but a more striking illustration could hardly be found than the one on the Thames Embankment, not far from that place, where Cleopatra's Needle looked down on the Jablochkoff candles at its base. He hoped the amount of speculation which had been taking place in connection with electricity, would be tempered with common sense, and that in the end no great harm would be done to anyone.

Mr. CURREY asked if Mr. Preece could give any definite information as to the amount of power used by M. Marcel Desprez to generate the half-horse power which he obtained in the Munich Exhibition.

Mr. PREECE, in reply, regretted that the questions asked were so few and simple. The one put by Mr. Currey was very pertinent, and he might say, at once, that although the experiment referred to was exceedingly valuable in showing that it was possible to bring half-a-horse power from a distance of thirty-four miles, in a straight line, which was equal to about seventy miles, because a double wire was used, still, the half-horse power received at Munich was only 25 per cent. of the power put into the machine at Miesbach. A gas-engine was employed there, and measured exactly, by the brake that was put into the dynamo-machine at Miesbach, 130 kilogrammetres, while it gave out at Munich 30 kilogrammetres, or, in other words, two-horse power were put into the machine at Miesbach, and half-horse power came out at Munich. This was not a very high result; at first M. Desprez, himself, thought that the machine at Miesbach was worked by one-horse power; but the careful measurement made by the jury had dissipated that illusion, and the French journals were now occupied in trying explain away the mistake made in the first instance. With regard to the observations of Mr. Shoolbred, was bound to admit that he had, very properly, taken him to task for not having given sufficient credit to the Committee of the British Association for the establishment of the units which were accepted at Paris. The Committee of the British Association had been sitting for twenty years, and had taken an almost indescribable amount of trouble, the result of their labours being to place the whole system of electrical measurements on such a plain and satisfactory basis, that it required very little difficulty to convince foreigners of its simplicity and coherency; and it was solely owing to the ground having been cleared beforehand by the British Association that the object was so completely effected at Paris. With regard to the effect of the Crystal Palace Exhibition in expediting the progress of electric lighting, he would ask whether the progress made during the past year, great as it was, was a healthy progress, and would not the progress have been much more solid, very much more commercial, and much more sensible, if there had been no Crystal Palace Exhibition to excite the cupidity of speculators? Although the progress had been great, the mania had been greater; and the number of enterprises thrown upon the world had been outrageous, chiefly due to the unnatural excitement produced by the exhibition. He would even ask whether the Act of Parliament was called for; and whether the discussion in Parliament with regard to it had not had a tendency to check that solid material progress which true scientific research and experiment would have created? In his opinion, the operation of the Act had been to check the progress of sound electrical enterprise in this country; it had been impossible to obtain from Corporations permission to lay wires underground, or to take any action whatever. Everybody had been waiting for this Act, and now it was passed, everyone was trying their utmost to strangle the electric bantling. He did not agree therefore, that the Crystal Palace Exhibition was the cause of healthy progress, and he had very considerable doubts whether it would not have been very much better for Corporations to have allowed solid companies to have worked their way quietly, and to have waited another Session for an Act of Parliament. One effect of these exhibitions he had omitted to mention, and that was the readiness with which wants were supplied when they were made known. Engineers, who had been accustomed to deal with large dynamo-machines, often found their watches act very eccentrically. Watches were usually made with vibrating springs of steel, and these springs, when they came in the immediate way of powerful dynamo-machines, became magnetised. When so magnetised, their movements became very irregular. If you laid a watch down at night north and south, it would very likely gain five minutes by the morning, whereas, if laid in the opposite direction, it might lose five minutes. But it was only necessary to point this out in order to have the evil remedied. He had found his watch become very eccentric in its movements from this cause, and he therefore, put it in the hands of Messrs. Dent. Since then he had been travelling all over England, in all sorts of weather, and had been amongst dynamo-machines so powerful that he could feel the influence of the current on himself, but his watch had gone with perfect regularity. That day he had compared it with the current from Greenwich, and found that in the last five weeks it had not varied two seconds. This was owing to the application of a new principle in the balance wheel, suggested originally by Mr. Crookes, and which had been adopted by Messrs. Dent and several other makers. He mentioned this to show how soon one's wants were met when they were made known, and one good result of the exhi-

bition was to afford opportunities of making known such wants.

The CHAIRMAN then proposed a vote of thanks to Mr. Preece, which was carried unanimously, and the proceedings terminated.

Miscellaneous.

REPORTS ON THE EXAMINATION OF THAMES WATER.

(Continued from page 76.)

MONTHLY REPORTS.

When the monthly reports were commenced, and up to 1876, only one sample a month from each of the companies was examined. In February, 1876, and since then, there have been daily samples of the water of each company reported on in this manner. In addition to this, particulars are given of the area, thickness, and composition of the filter-beds, and the condition of the water at the intakes.

Information respecting the chemical analysis of a water, one of the subjects "in addition," was first introduced into Colonel Bolton's monthly sheets in December, 1873. A special column, "Analysis of the Water," was then commenced, and was continued till December, 1874, when it ceased, and has not been revived. In the sheet for December, 1873, the analysis of the Kent, the New River, the East London, and the West Middlesex, were made by Dr. Letheby; that of the Lambeth was made by J. K. Bamber; while there was none made for the Southwark and Vauxhall, the Grand Junction, and the Chelsea. They are made "for the company." No reference was made in any way to explain why they were introduced, whether the companies thought that they thus showed how good their water was, or whether it was simply as a means of comparing results given in the returns to the Registrar-General is not explained.

The facts, taken as they stand, however, are as follows:—The waters of the companies had been analysed monthly, regularly for fourteen years for the Registrar-General, when the "water examiner's" monthly sheets were commenced. Nothing on analysis was given in them, till the column referred to, "analysis of the water" made for the companies, was introduced. When this was given up in December, 1873, information respecting analysis was given on the back of the sheet; but it was something more than a mere change of position. The change began in the January sheet 1875. The Water Examiner* then, for the first time, introduced a copy of the report made to the Registrar-General by Prof. Frankland. There is no title for the office held successively by Dr. Thomson, Prof. Hofmann, and Prof. Frankland, such as "Water analyst." It would be convenient to have such a term, for though freedom from error in an analysis is not secured by its being "official," much stress is often laid in the controversies on London water supply, on the distinction between "official" reports and those made "for the companies." Prof. Frankland's first report in the sheet for May, 1874, on the Lambeth company's water, is stated to have been made "for the company."* A question was raised in Parliament last Session, as to whether certain monthly reports with an official looking title were official or not, and the reply was, that they were not. For want of some official title, such as "The water analyst," it often takes two or three lines of explanation to ensure accuracy of description in quoting reports. Colonel Bolton has endeavoured, in his monthly table, to give such information respecting the water as is likely to be of use, and, if there is no direct authority for printing reports of the analyses made "for the companies," it is in accordance with the spirit of Clause 36, of the Act of 1871, which provides that "the company may, if they think fit, on each occasion of such examination, be represented thereat by some officer, but such officer shall not interfere in the examination." There is a want of distinctness as to what is published by authority and what is not. The Acts, which are the sources of authority, are vague; the practice based on these Acts is variable. It is evident, that if the bare wording of the Acts only had been complied with, there would have been much less information available respecting London water supply than there is at present. On the other hand, for cases where it is important to distinguish between an official and unofficial report, it is difficult, if not impossible, to pick out what is included in a report, because it is useful, and what is included, because it is required to be there. For example, the report on the water supplied to Birmingham, and the water supplied to Glasgow, is sent in each month by Professor Frankland to the Local Government Board. His own report of the analysis of the waters of the London companies is the official and only official report; but it is by no means clear how the reports for Birmingham and Glasgow stand.

This account of Colonel Bolton's series of reports does not attempt to decide what is official and what is not.

The change introduced in January, 1875, mentioned above, was accompanied by another change. By the side of the table, taken from analyses reported to the Registrar-General, in which the results are

* In the margins of the appendixes of the Local Government Board reports, the short titles given are: "Colonel Bolton's report," "Prof. Frankland's report," but they are indexed under their full title.

* Professor Frankland states that he never analysed any water from the Lambeth Company, and that the figures given in Colonel Bolton's report of the water of this company, are the same as those of the analyses made officially for the Registrar General, in May, 1874; and published in the *Weekly Return*, for the week ending, May 30, 1874.

given in parts, per 100,000, is a table in which the same facts are given expressed in "grains, per gallon, for comparison with analyses furnished by water companies," and, under these, was given a table of the analyses made by Dr. Lethaby on behalf of the companies. In February the same plan was followed, the only change of importance being, that Prof. Frankland's analyses was addressed to the secretary of the Local Government Board not to the Registrar-General. His table was on the same general plan as now, except that there was a column, "Previous sewage or animal contamination, estimated," which was discontinued after January, 1877. The three tables were continued in this way for nineteen months; but in September, 1876, table No. 2 was discontiuued, thus leaving the comparison of the parts per 100,000, and the grains per gallon of table 3, to be worked out by those who cared to do so. Table 3 was continued by Dr. Letheby up to February, 1876. In March, 1876, and subsequently, this table was supplied by Dr. Meymott Tidy, but in June its title was changed to "Results of analysis, made . . . . . for the Society of Medical Officers of Health," and with this title, it was continued till December, 1879, when it disappeared. In the April of 1876, another change in form, and another set of tables was introduced. In the column, "appearance of water," which was first spaced out for the daily observations in February, 1876, and which hitherto had been devoted only to statements about clearness, there was introduced tables of analyses made "for the companies." The first was by Dr. Whitmore, for the West Middlesex Company. In the June sheet, at the end of paragraph 12, is this sentence: "The analyses furnished by water companies are given in the within report, under the head 'appearance of water.'" The exigencies of finding room for further information in the already crowded sheet was no doubt the reason for utilising the spaces in between the lines giving the statements as to appearance. It, however, makes the column contain not only two classes of observations—one physical and the other chemical—but two sets differing in their origin, one official and the other not. The statements as to clearness are the official reports of "the water examiner." These statements indeed constitute the report as required by Section 36 of the Act of 1871, while the analyses "furnished by the companies" are optional. With this re-introduction of the analyses "as furnished by the companies," there were at this time three series of analyses given in the report. 1. That reported officially to the Local Government Board. 2. Those made by Dr. M. Tidy for the Society of Medical Officers of Health; and 3. Those made by different analysts for the different companies. Series 2 was discontinued after December, 1880. The printing of the dates on which the samples were collected were given up to the end of 1879. In a paper read before the Chemical Society in December, 1878, Dr. Tidy wrote—"I was most anxious that Dr. Frankland and myself should examine samples taken at the same time, so that our results might be strictly comparable, and that this could not be arranged was no fault of Dr. Frankland's or of my own, as he himself expressed to me his desire and willingness to make the necessary arrangements, which, however, were interfered with. . . ."* Though the dates on which samples had been taken never had coincided, they were given, and as they were taken on one day in each month only, there was some rough guide. Coincident with the cessation of the dates, there was an entire change in the way of expressing the results obtained. Just before the cessation of Dr. Tidy's series, there was introduced in the November sheet (the sheet for October), Messrs. Wanklyn and Cooper's series of reports.

Though, therefore, similar in appearance for so many years, the monthly sheets of the water examiner have varied much in the matter given "in addition to" the official report.

When Dr. Tidy's reports ceased, those of Messrs. Wanklyn and Cooper took the second place, *i.e.*, immediately after Prof. Frankland's, and a totally new series was introduced in the third place, viz., the report by the Society of Public Analysts. The reports made the companies were the analyses of Drs. Tidy, Whitmore, or Bernays (the Grand Junction Company sometimes sending two reports). The reports of the Society of Public Analysts introduced a number of new names into the monthly sheet, but the report was given only in January and February, when the want of uniformity was severly criticised.

No further change took place till the introduction of the report by Messrs. Crookes, Odling, and Tidy.

Registrar-General's Report.

In the weekly return of the Registrar-General for October, 1857, p. 334, there is given an analysis of the water of the Southwark Company, by Dr. Robert Dundas Thomson, of St. Thomas's Hospital. This appears to be the first time that water analysis found a place in these publications. Dr. Thomson, in November, first supplied the analyses of the waters of the various companies, and his reports for November and December are given in the first number (for January), 1858; from that time, he continued to furnish monthly reports till June, 1864. It would be interesting to know the history of thought on the subject of water in connection with health, at the period 1850 to 1860. In the "Notes on Previous Enquiries," there was brought together as much as could be found of printed opinions, and of records of the investigations made to estimate the truth of the supposition that disease might be spread by water; a supposition arising with, or at least brought forward by, Dr. Snow. But beyond these records, except, perhaps, in the daily press, there is no indication that the subject did receive much thought. The inquiry into

* The conclusion of the sentence refers to official difficulties.

the 1849 outbreak of cholera probably drew attention first to the subject, and in the writings of Simon and Farr will be found probably all that is of lasting value. But the inquiries were of a purely statistical character, the chemical examination of the water was not included. That water had any influence at all in connection with disease was an idea pronounced, in eloquent language, as preposterous, and was evidently only timidly and cautiously admitted by those that did admit it. The inquiries of 1851 and 1856, however, were specially directed to chemical subjects, and instructions as to the points on which information was wished, were issued. By 1857, the chemical analysis of a company's water found a place, as mentioned in the Registrar-General's Report. From 1858, "monthly analyses," that is, monthly returns stating the results of analyses of water, taken one day in each month from a company's supply, have been issued, except for the months from July, 1864, to Jan. 1865. Dr. Thomson supplied them gratuitously at first, but after January, 1862, the Treasury allowed a small annual payment for them. They may be regarded, therefore, as official from this date. The gap from July, 1864, to Feb. 1865, was caused by Dr. Thomson's death.

The analyses for February, March, April, and May, 1865, were made by Professor Hofmann, and that of June, by Professor Frankland, who has regularly furnished the monthly analyses since. The place in which this series of monthly reports is issued, is the "Weekly Returns of Births and Deaths in London." The report for a month is generally given in the number for the second or third week of the succeeding month. It has sometimes been later, and as there is no index, there is no other course for those who wish to consult a series in any period, than to look through the weekly returns. In almost all cases, in addition to the mere table of figures, there is a more or less extended report, whilst occasionally, as during the prevalence of a cholera epidemic, special and elaborate reports have been given (see Registrar General's Weekly Returns for 1866, p. 451); but to these, again, there is no index.

In the 1866 rep., supp., p. 257, app., is a summary and comparison of 1850, 1856, and 1866.

Besides the weekly returns, there is an annual publication of the Registrar-General, in which, since 1867, Professor Frankland has made a formal "Report on the analysis of the waters."* The first was a report of three pages, with five pages of tables. (In the previous year there was a letter of half a page.) This annual publication is quite distinct from the annual report of the Registrar-General. It is a summary of the weekly returns during the year; it was not, however, called a summary on its title page, till 1866, and it was not until 1870 that the title page bore "Annual Summary." It is now commonly quoted as the annual summary of the Registrar-General. In everything but the title, however, it is practically the same sort of publication as it was in 1860, when the title was "Weekly Tables of Births, Deaths, and Causes of Death, in London, during the year." To those not acquainted with these changes, there might appear to be two distinct series.

* The Annual Reports of Professor Frankland were not brought under notice in the article printed in the *Journal* of September 8. The monthly reports only are mentioned at p. 673.

The Object of the Tables.

The explanation of what the tables given in the reports mean, and what is supposed to be the value of the determinations, must be sought principally in papers read before the Chemical Society. The most important of these papers are:—Prof. W. A. Miller in vol. xviii., 1865; Prof. Frankland in vol. xix., 1866; Prof. Wanklyn with Messrs. Chapman and Smith; and another by Prof. Wanklyn in vol. xx., 1867. Then in the next year, 1868, vol. xxi., four papers, by Prof. Frankland and Mr. Armstrong, by Prof. Frankland, by Prof. Wanklyn and Messrs. Chapman and Smith; by Mr. Chapman;* in vol. xxix., 1876, by Prof. Frankland; in volume for 1878, by Dr. Mills; in volume for 1879, Dr. M. Tidy. In volume for 1880, Miss Halcrow and Prof. Frankland, and a second paper by Prof. Frankland alone.

Prof. Miller, in his paper, pointed out that "there is much less agreement between different operators in the exact modes of conducting the details of the analysis than might have been expected." This was in 1865, after the Registrar-General's reports had been given for eight years. The paper is an important one, as it was written "with the hope of contributing something towards facilitating greater uniformity in practice, and of adding precision to the results obtained," and the methods referred to were selected "from every available source." The subjects referred to, include:—(1) The use of the two-foot tube for testing clearness; (2) the arbitrary scale of colour; (3) amount of sediments; (4) taste; (5) odour; (6) hardness; (7) the determination of the amount of organic matter, "as it is often loosely termed," by evaporation and incineration; (8) the use of potassic permanganate (to which four pages is given); (9) the gaseous constituents; (10) estimation of ammonia; (11) estimation of nitrites; (12) estimation of nitrates.

Prof. Frankland's paper, in 1866, gives an explanation of the methods employed by him in the analysis of metropolitan waters. The details of the process for determining by potassic permanganate, the amount of oxygen required to oxidise the organic matter present are given, and the paper is accompanied by five charts, which show the monthly fluctuations. Messrs. Wanklyn, Chapman, and Smith (1867), after stating that the processes employed in water analysis have never been properly investigated, criticise the value of the processes and propose the ammonia process.

* Then, for eight years, there is no paper of importance.

The paper by Prof. Wanklyn alone, is in verification of the previous paper. Prof. Frankland and Mr. Armstrong, 1868, drew attention to the "formidable difficulties" which surround water analysis, and give the result of two years' work on the value of the following determinations:—1. The estimation of total solid constituents. [The omission of sodic carbonate is recommended.] 2. The estimation of organic and other volatile matter. [The difficulty of determining the meaning of loss on ignition is mentioned.] 3. Determination of the amount of oxygen necessary to oxidise the organic matter. [The untrustworthiness of the permanganate process, is particularly mentioned.] 4. Estimation of nitrous and nitric acids. 5. Estimation of ammonia. The processes proposed as substitutes are then given. Messrs. Wanklyn, Chapman and Smith, in their paper, deal critically with this paper, and write in vindication of their process. The paper by Dr. Tidy (1879) includes a description of a new process, which he calls the oxygen process, and in this the real value of the permanganate test is entered into at considerable length. The uncertainty of a colour test, owing to the fact that so many people suffer from partial colour-blindness is specially dwelt upon,

The ignition process, the combustion process, and the ammonia process are all considered critically.

The examination of the waters of the London Companies, by Messrs. Crookes, Odling, and Tidy, is made in accordance with the views expressed in this paper. They give four examinations a month of each of the companies, and, in the spring of this year, issued a set of coloured charts, summarising the results of March (including part of February) to December of last year.

It will be noticed in the reports that all analysts, in addition to their results, give expression to opinions which involve physiological and pathological considerations.

THE FISHERIES OF JAPAN.

Consul Smith, of Nagasaki, says that the fisheries of Japan constitute one of the most important industries of the country, and that an approximate idea of the extent of the business, and the number of people engaged in it, may be formed, when it is considered that the population of Japan is about 35,000,000, and fish is the chief article of food which enters into the consumption of every Japanese household, and a very large trade also is carried on in preparing and exporting dried fish to China. In the district of Nagasaki alone, there are nearly 70,000 persons, of both sexes, engaged exclusively in the business of the fisheries, whose annual receipts, for the sale of fresh fish, amount to over £1,000,000. The fisherman's boat is generally from twenty to thirty feet in length, and proportionately wide, and is constructed of light, strong wood, and propelled with great rapidity. Sculling is the method universally used among the Japanese. The oar or scull consists of two pieces, one joined to the other, overlapping about the middle; On the handle is a pin, on which a rope is slipped, so that the oar is held down to a uniform height, while being worked. The blade is flat, and long, and rests near where it joins the stock, on a pivot; the sweep of the stock, at the hand, is about three feet. The same model of boat, but smaller in size, and of neater construction and finish, some with a little cabin in the fore-part, called "house boats," are used everywhere in the waters of Japan, under the general name of "sanpan." The larger fishing boats, called "kotsu-fuai," are made to carry from thirty to forty men; they are propelled both by sculls and bamboo sails, and are used in catching deep sea fish, the albicore and the bonita; the former is a fish from four to six feet in length, and weighs from 150 to 200 pounds; the latter weighs from ten to twenty pounds. Both these fish are caught with hook and line, and often in the seine. The smaller fishing boats are constructed with a division in the centre, with openings for the water to enter, in which the fish are kept alive. Much of the fishing is done in the night time, when the torches of the fishermen light up the sea. The fish are attracted by the light, and are speared from the boat's sides, as well as taken by the hook. The greater portion, and especially the smaller and most common varieties, are taken in stationary nets, in comparatively shallow water, from ten to twenty fathoms deep; some of the nets used will cover an acre of surface; they are in the shape of a triangle, the finest meshes are at the apex, and gradually enlarge as they extend towards the base. The apex is held in place by a buoy composed of bamboo poles, and bunches of these are also placed at intervals along the sides and across the base of the net. The centre of the net falls to the bottom, while the large meshes at the outer sides permit fish of all sizes to enter. When it is desired to make a haul, boats pass along the base, and the net is gradually gathered up as they near the apex. In this way the fish are driven into the finer part, when they are secured by dip nets. The large net is at no time taken into the boats, but passed under the bottom as they approach the buoy, and at the end is ready set for another haul. The other seines used by the Japanese do not differ in any material degree from those used on the Atlantic coast. The larger and rarer kinds of fish are taken by the hook. The common and coarse flesh fish, such as sharks, skates, and mackerel, are very abundant in Japanese waters, and are largely consumed by the poorer classes. Young sharks are highly esteemed by the natives. The most valuable of all the food fish is a sea bream, which is known in Japan as the "tai." A species of sardine, of excellent quality, is found here also in great abundance, and is used in a dried as well as in a fresh state. To take them two boats usually go out together, under sail before the wind, with a line from each boat, holding the net between them; when the catch is made, the boats approach each other, and the net is

drawn up. They are preserved alive for market in bamboo baskets sunk in the water. Salmon are caught in great abundance in the northern part of Japan, in the neighbourhood of Hakodate, where a large river empties into the sea. The fishery at the mouth of this river is said to yield, annually, about £12,500 in salmon and other fish. The fishing season there is in September and October, and the nets used are, some of them, 400 feet long, by 40 feet deep, and require about seventy men to haul them. Ten thousand salmon have been caught at one haul of the seine; smaller nets, in poor seasons, take 700 and 800 salmon in a day, in fact, so plentiful is this fish in many parts of Japan, that fish manure is an article of standard manufacture, sale and use. In April and May, many whales are taken near Hirado and the Goto islands. During these months, the whales are passing to the northward, and linger in the vicinity of Nagasaki, on account of the fishing grounds. When a whale is discovered, from six to twenty boats put off in pursuit; some of them spread a vast net in front of it, while the others attack with harpoons and lances, the former being thrown high in the air, and coming down with the barbed point into the flesh. The flesh of the whale is esteemed a great luxury by the natives, and brings the highest price in the markets. Nearly every kind of fish is eaten by the Japanese, and the multitude and variety of the choicest edible fish is remarkable. The markets are places of curious interest, and show many strange species, from the beautiful flying fish, to the shark and devil fish. In the early days, it was customary to eat live fish, and even now, there are certain choice fish which, when the seines are drawn, the women cut open and devour while still alive.

PHOTOMETRIC STANDARDS.

The following is taken from the last annual report ot Mr. T. H. Farrer and Mr. H. J. Chaney, on the work of the Standards Department:—The practical working of the Sale of Gas Acts has been brought under the notice of the Board, and communications with reference thereto have been addressed to local authorities and gas companies. It is hoped that an opportunity may shortly be afforded of laying before Parliament a Bill for consolidating and amending the enactments for regulating measures used in the sale of gas, and of dealing with the mode of testing the illuminating power of gas. By certain local Gas Acts it is provided that the "standard burners" by which the quality of the gas is to be tested, should be of the same form as the standards deposited with this Board, and during the past year several standard burners have been verified. There have also been verified photometric apparatus, and other standards, for Sydney, Adelaide, and South Australia. During the past year, forty-two petroleum-testing apparatus have been verified and stamped at this office. An omission in the rules for testing petroleum, as laid down in the "Petroleum Act, 1879," has been pointed out by Dr. Foerster, the Director of the Imperial Standards Commission of Germany. In these rules no allowance was made for variations of atmospheric pressure at the time of determining the "flashing-point" of the oil under test. A necessity for such allowance is shown by the fact that some oils which were recently tested in London, when the barometer read 29·80 inch, showed a flashing-point of 89° and 74° Fahrenheit's thermometer, respectively, but when tested at Buxton, with the barometer at 28·35 inch, the same oils "flashed" at 86° and 72° F. respectively; so that the oil which would have "passed" in London at 74°, would not have "passed" at Buxton, where it was found to flash at 72°, or 1° under the legal flashing-point of 73° F. In Sierra Leone, the importation of petroleum has been lately provided for by the Petroleum Ordinance, 1882. By this Ordinance, all petroleum is to be tested by the apparatus described therein, and any oil which gives off an inflammable vapour at a temperature below 95° F. is not to be imported. The apparatus adopted is the old form of open test described in the Imperial Petroleum Act of 1871, but the standard temperature of 100° F. provided by that Act, has not been followed. In India (Commons, No. 290, 1882), important questions have also arisen with reference to the use of the testing-apparatus in that country, samples of oil tested at New York having been found to give at Calcutta a lower flashing-point than when tested at London and New York.

JAPANESE SEAWEED.

Consul Quin, writing on the trade of Japan, mentions that a considerable increase has lately taken place in the exports of seaweed, and gives in his last report the following description of the method in which cut seaweed is prepared for the market. For making the finest cut seaweed, the best long seaweed is used, the newer the better, on account of the colour. After the bundles are opened, they are picked, and as much sand as possible shaken out; the selected weed is then placed in large boilers, and is boiled for an hour or more, until the proper colour is obtained, which should be quite uniform and of a good clear green. After boiling, the seaweed is hung up on poles in the air to partially dry it, after which it is again carefully sorted, and all ragged pieces and those of a pale whitish colour are rejected; the selected weed is then handed over to a number of women, who open it out and roll it into flat coils of about ten pounds each. As soon as these coils have remained long enough to flatten the seaweed, they are uncoiled, and the pieces of weed are laid out one on the top of the other on a board a little over four feet long, to the depth of eight to ten inches; they are then cut into four lengths of thirteen inches each, and these pieces are tied into bundles ready for

the workmen to lay in the presses, which are about six feet wide, thirteen inches deep (the length of the pieces of seaweed), and six feet high. At the bottom a row of wooden slats, about two inches and a-half broad, half-an-inch thick and thirteen inches long, are placed edgeways, and upon these the weed is laid carefully piece by piece in the frame, the sides of which are kept in position by a rope stretching across the top; a movable plank at the back, which is raised as the workman proceeds, keeps the weed thoroughly even. When the frame is full—about two tons going into one press—a similar lot of slats to those at the bottom are placed on the top of the seaweed, and the whole is pressed as tight as possible, by means of a rough capstan, to get rid of all unnecessary moisture, and to render the mass firm enough for cutting. The frame is then laid down flat; and one of the side planks being removed, the compressed weed is planed with an ordinary carpenter's plane, set so as to cut it to the required thickness—about one twentieth of an inch—along the edges and with the grain. The object of the slats is to enable the workman to plane to the edges, and they are removed one by one as he progresses with his work. Each man can plane on an average, one hundred and seventy pounds of seaweed per day. After planing, the cut seaweed is taken out of doors and shaken out to dry on mats; under favourable circumstances, one day is sufficient for this operation, but it frequently happens that as many as three days are required before it is dry enough to pack away. After the final drying, the weed is ready for the market, and is packed away in boxes containing about sixty-six pounds each. The rejected ends of the first-class seaweed are used up together with ordinary long seaweed of an inferior quality, to make cut seaweed of a lower class. While undergoing the various processes, the material loses 20 per cent. in weight, and that fact, joined to the price of the labour expended in its manufacture, brings the cost to more than double the average of long seaweed.

THE IRON ORE FIELDS OF LAPLAND.

Consul Drummond-Hay, in his last report on the trade and industries of Sweden, calls attention, as being a source of considerable wealth to that country, to the existence of iron ore fields in Lapland, and states that so important have they become, and such opportunities exist for the development of a large export trade in iron, especially with Great Britain and America, that it is intended to construct a railroad from Ofoten-Fjord, a harbour on the north-west coast of Norway, to Haaparanda, in the Gulf of Bothnia, with the main object of working the inexhaustible mines of ore in the north of Sweden. In the district extending from Gellivara, in Lapland, to the north-west, as far as the Norwegian borders, comprising a large portion of the village of Jackasjärvi, there are large and rich fields of iron, including other descriptions of ore. They were discovered in the commencement of this century, but never properly surveyed until the year 1874, when the chief Geological Surveyor of Sweden was appointed by the Government to proceed to the site, and acquire a specific knowledge of the iron ore beds. The official report on the subject has appeared, and contains a minute description of the Luosavaara, Kirunavaara, Soappaara, and Gellivara beds, together with other mines of less importance. The following extracts from the report are limited to the Luosavaara and Kirunavaara beds, which, owing to their proximity to the harbour would, in all probability, monopolise the western export trade. These beds are situated close to latitude 68° and about 21° east of Greenwich. There are two villages situated to the north and east of the beds where corn and potatoes are cultivated. The province of Norbotten, which lies to the south, and is included in Swedish Lapland, was, according to the census of 1875, inhabited by a population of 12,449 souls, of whom one-third were nomad Lapps, the remainder were Swedes and Finns, employed in agriculture, cattle-breeding, fishing, hunting, and the timber trade. The extent of the Luosavaara ore bed is 1,330 yards in length, and the widest part is 46 yards broad. The whole covers an area of about 12 acres. It is calculated that there are 2,700,000 tons of iron ore above the surface of the lake of Luosajärvi, and below that, 230,000 tons for each yard in depth. Seven general samples of ore have been analysed and found to contain a minimum of 68·1 per cent., and a maximum of 73·1 per cent. of iron; the proportion of phosphorus, varying between 0·003 and 0·082, was in all the samples on an avarage 0·029 per cent. The Kirunavaara bed is situated about three English miles to the south of Luosavaara, about 100 miles from the harbour of Ofoten-Fjord. The ore extends, without interruption, to a length of 4,160 yards, the breadth varying from 50 to 230 yards, and the whole covers an area of 76 acres. A large portion of the bed is impregnated with phosphorus, but there are three tracts where the phosphorus varies from 0·03 to 0·047 per cent., the proportion of iron being from 71·4 to 73 per cent., and it is calculated that those parts alone would produce 56,650,000 tons above the level of the Luosajärvi lake; the total quantity, therefore, of iron ore in Luosavaara and Kirunavaara together, above the level of the lake, is computed at 83,650,000 tons, suitable for Bessemer steel; and, in addition to the above, there are about 203,864,000 tons above the same level, which could be utilised by the dephosphorising process. The average temperature at Ofoten-Fjord during the coldest month in winter is only 4° below freezing point, the harbour would thus be navigable and open to shipping in all seasons of the year. It is proposed to run the line from Ofoten to the mines of Luosavaara, Kirunavaara, and Gellivara, and thence to the nearest and most convenient harbour on the Baltic, where it would be continued along the coast to Haaparanda. A Russian-Finn railroad would then be constructed, *viâ* Uleaborg,

to meet the new line at Tornea. The distance from Ofoten to Kirunavaara and Luosavaara is about 100 English miles, and the entire length of line to Haaparanda, would be about 320 miles. The most costly part of the railway would be from Ofoten, across the Norwegian frontiers, where the highest point is 1,600 feet above the level of the sea. This part of the line would be, however, only twenty-five miles in length. It has been calculated that the whole line would cost about £2,000,000, or about £6,000 per mile. Consul Drummond-Hay is of opinion that an annual export of at least 1,000,000 tons might take place from Luosavaara and Kirumavaara, and taking it at the rate of 4s. per ton, a gross income of £200,000 would be derived from the iron ore alone.

RAILWAYS OF THE WORLD.

An article by M. Paul Trasenster, of the Government School of Mines at Liege, tracing the growth of the railway system of the world, is quoted from the *Revue Universelle des Mines* in *The Economist*. Starting with the year 1840, when railway construction was in its infancy, M. Trasenster shows how the 5,000 miles of line then in operation have grown into total of nearly 250,000 miles, and how the system, which was then practically confined to a few European countries and the United States, has now spread to all quarters of the globe. In the subjoined table the progress of the development is shown in detail, and it may be summarised thus:—

LENGTH OF LINES IN OPERATION ON THE 31ST DECEMBER.

	Europe.	America.	Asia.	Australasia.	Africa.	Total.
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
1881.....	108,002	122,186	10,774	5,481	3,147	249,590
1880.....	105,429	109,521	9,948	4,889	2,904	232,691
1879.....	103,237	101,196	9,269	4,363	2,705	220,770
1875.....	89,323	84,648	7,072	2,312	1,552	184,907
1870.....	64,667	58,848	5,118	1,042	956	130,631
1860.....	32,354	33,547	844	350	298	67,393
1850.....	14,551	9,604	...	...	...	24,155
1840.....	2,131	2,859	...	...	...	4,990

The rate of progression, it will be observed, has been rapid, and, on the whole, continuous. There has not, of course, been an equal development each year. In years of prosperous trade and active speculation the work of construction has been pushed on with great energy, while in times of depression it has languished.

Between 1870 and 1881, the year of least activity was 1878, the length of new line opened in that year being slightly under 8,000 miles; while, on the other hand, the year 1881 was one of exceptional activity, no fewer than 15,100 miles of new line—that being the largest total ever recorded—having been added to the various systems. Passing from the record of the past to the prospects of the future, M. Trasenster takes a survey of the position of the various countries in which the work of railway construction is being carried on.

On the whole, the probability seems to be, that in the immediate future the railway systems of the world will be developed with much greater rapidity than has yet been attained, and M. Trasenster estimates that the increase in 1883 is not unlikely to be as much as 17,000 miles. Whether such a rapid growth can long be sustained is another question.

PAPER FROM BARK.

The strongest and commonest of the several Japanese papers is made from the bark of the *Mitsuma*, a shrub which attains about a yard and a-half in height, and blossoms in winter, thriving in a a poor soil. When the stem has reached its full growth, it is cut off close to the ground, when offshoots spring up, which are again cut as soon as they are large enough.

A paper of superior quality is made from the *Kozu*, a shrub of the mulberry family, which grows to the height of two yards and a-half. It is a native of China, and has not long been imported into Japan, where it is now much cultivated. The stocks are planted two feet apart, often serving as hedges for separating the fields. The shoots which, under good conditions, attain their full size, are cut down in October, on the fourth or fifth year after planting.

Paper is made with these two descriptions of bark in the following manner:—The twigs are steeped in water for a fortnight, when the outer portion becomes detached, and is carried away, if in running water. The inner bark is removed, washed and dried, and then subjected, for three or four hours, to the action of steam and boiling water, which softens it. It is then struck with staves, until a fine paste is formed, which, mixed with water, serves to make paper by a process similar to that employed in Europe.

Kozu paper is very strong in the direction of the fibres, and to obtain paper of equal resistance in every direction, two, three, or four thicknesses are superposed, with the fibres running in different directions. It is thus that the strong papers are obtained, that serve for covering umbrellas and other similar purposes, as well as artificial leather. The Japanese also make from the *Gampi* a transparent paper as strong as that from *Kozu*, but much finer and more supple.

DANGEROUS AND UNHEALTHY INDUSTRIES IN FRANCE.

The French Government has, on the report of the Minister of Commerce, and in concurrence with the Superior Commission appointed by law, issued six decrees forbidding the employment of children and young women under age, under the following circumstances, and for the specified reasons:—

Manufacture of salicylic acid by means of carbonic acid, on account of the corrosive emanations. Manufacture of celluloid and similar products, on account of the injurious fumes and dangers of explosion, or of burning; and, for the last two reasons, in works for fashioning celluloid. Manufacture of chloride of sulphur, on account of the injurious emanations.

It is also forbidden to employ boys under sixteen, and girls under eighteen, for supplying motive power to hand-looms; and the work of young women under age is prohibited in rag works that are not properly ventilated.

Boys of twelve to fourteen, and girls of twelve to sixteen years, may not be employed to draw loads in the public streets. Boys and girls over twelve may draw loads in manufactories, works, shops, and yards, provided it be on level ground, and that the load, including vehicle, do not exceed two cwt.; and only boys from fourteen to sixteen years old may draw a load in the streets, provided it do not exceed one cwt.

Children may not be employed in operations in which dust is disengaged, in works where horn, bone, and pearl is worked dry. Nor may they be employed at all in such works when dust is freely disengaged.

Lastly, plumbers and tilers are forbidden to employ children in work executed on the roofs of houses.

Correspondence.

BRITISH RAINFALL.

I am just preparing to issue to all the observers of rainfall known to me, blank forms for the entry of their records for the year shortly about to close. This staff now exceeds 2,000, but still, as they are not unfrequently rather clustered, there are many parts of the country where additional records are needed. I have no doubt that records are already kept in many places unknown to me, and I shall be glad, if you will allow me, to invite communications from any one who has kept an accurate record, and to supply either those already observing, or contemplating doing so, with a copy of the rules adopted by British observers, and with all necessary blank forms—all, I may perhaps as well add, free of charge, as our greatest requirements are ample and accurate records.

G. J. Symons, F.R.S.

62, Camden-square, London, N.W.

Obituary.

Sir Thomas Watson, Bart., M.D., F.R.S.—After a long illness this eminent physician died at Reigate-lodge, Surrey, on Monday, 11th inst., at the age of ninety. Sir Thomas had retired from practice for several years, but he never ceased to take a vital interest in the proceedings of the profession of which he was one of the most distinguished ornaments. He was Physician in Ordinary to the Queen, and held the office of President of the College of Physicians for several years. He was elected a member of the Society of Arts in 1854.

General Notes.

Behaviour of India-rubber when Subjected to Tension.—As a result of a series of experiments made on some samples of vulcanised Para india-rubber, M. Jenatzy, of Brussels, found that, under uniformly increasing loads, a band of caoutchouc takes increasing elongations until it becomes twice as long as it was originally, after which the successive elongations decrease; and he also finds that the weight necessary to quadruple the length is three times that under which the length has become doubled.

Conference for the Protection of Submarine Cables.—The Conference, which opened at Paris on 2nd October, with the object of recommending measures for the protection of submarine cables, was closed on 2nd November by a speech from the president, M. Cochery, the French Minister of Posts and Telegraphs. He congratulated the representatives of the thirty-two countries that had taken part in the Conference on the results achieved, viz., the authorisation to prepare an international convention to be submitted to the various Governments, and which, he expressed his conviction, would soon become law.

Electric Head-light for Locomotives.—The electric light, which has already been applied to the mast-head of steam vessels, has now been also tried for the head-light of locomotives. An electric lamp of 5,000-candle power, was fitted, in March last, in front of the locomotive "Frohsdorf," of the Kronprinz Rudolf Railway, the generating machine, on the Schnekert system, being mounted on the shaft of its independent motor, a three-cylinder Brotherhood engine. The light is concentrated, and projected in front of the engine, by a parabolic reflector, and may be turned on either side to a certain extent at the will of the driver.

The Wax Plant.—The wax plant, indigenous in Carolina and Pennsylvania, is now being cultivated on a large scale in Algeria, while its acclimatisation in Tunis has been attempted with favourable results. The fruit, enclosed in a bag of coarse cloth, is plunged into boiling water, and in a few seconds the liquid wax floats on the surface. This is skimmed off and dried, and forms a good substitute for beeswax, as it has the same chemical composition. Its odour is agreeable, the root pos-

sesses medicinal virtues, and the leaves are useful for protecting textile fabrics from the ravages of insects.

EARLY GAS-ENGINE.—The following description of an early gas-engine, taken from the *Scientific American*, of July 23, 1846, is quoted from the *Printing Times and Lithographer*. The engine was at that time to be seen at the store of Samuel Perry, in Front-street, near Whitehall, in New York. "The machinery consists in part of a cylinder, piston, pitman, flywheel, and governor; in this respect similar to a steam-engine. A small quantity of spirits of turpentine is kept in a warm state, and the vapour arising therefrom is mixed with fifty times its volume of atmospheric air. A small quantity of this hydrogenated air is drawn into the cylinder, and ignited by a movement of the machinery, producing a slight explosion, whereby the remaining air—at least nine-tenths of the whole—becomes so heated that it drives forward the piston with great force. This engine is said to be capable of working ten-horse power, and it is intended to substitute rosin instead of turpentine, which will reduce the expense of feeding it to about 50 cents per day. The ingenious inventor has had some difficulties to encounter in the construction of the first engine, but has a fair prospect of being well remunerated for his labour."

AGRICULTURAL CONGRESS.—The *Société Nationale d'Encouragement à l'Agriculture* have decided to hold a Congress at the Hotel Continental, Paris, in connection with the cattle show, that opens on 22nd January next. The questions to be debated are the following:—1. Influence of mechanical industries on rural habits. 2. Necessity of employing mechanical processes to compensate for diminished agricultural labour. 3. Importance of mechanical work in the cost price of agricultural products; and economy realised by the use of improved machinery. 4. Methods for generalising the use of machinery; purchases and loans by agricultural societies; local associations and contractors; formation of large manufacturing works. 6. National and foreign manufacture. 7. Agricultural transport and small-gauge system. 8. Influence of the development of irrigation on the cost price of fodder, cattle, and manure. 9. The management of water as motive power, and as an agent of transport and fertilisation. 10. Vintage economy and the measures against the phylloxera. 11. Electrical transmission of power to a distance in rural districts.

THE MERCHANT MARINE OF THE WORLD.—According to statistics, published by the *Bureau Veritas*, a Continental Underwriters' Association, like Lloyds, it appears that the use of sailing vessels continues to decrease, while that of steamers is increasing rapidly. For 1882-3, the number of sailing vessels is 48,487, gauging together 13,739,970 tons. The following are the numbers possessed by those countries which contribute more than 1,000 each to the general total:—England, 18,035; North America, 6,057; Norway, 4,112; Italy, 3,054; Germany, 2,871; France, 2,536; Russia, 2,155; Sweden, 1,976; Greece, 1,809; Spain, 1,555; Holland, 1,221, and Denmark, 1,165. For the same year, there are 7,301 steam vessels of 8,404,932 gross, and 5,479,441 net tonnage, of which more than half, or 4,317 vessels, gauging 5,352,549 tons gross, and 3,462,877 tons net, are owned by England. Next in order comes:—North America, with 594 steamers; France, with 414; Germany, with 354; Spain, 252; Sweden, 246; Russia, 189; Norway, 185; Denmark, 133; Italy, 127, and Holland, 121. The other countries, including Central and South America, have less than 100 steam vessels.

THE AUSTRIAN METAL INDUSTRY. — The Trieste exhibition of the united industries of Austria and Hungary has brought into prominence the manufacturing resources of that part of Europe, in connection with the metal industry. Carinthia and Styria produce various kinds of wire, particularly fine descriptions, piano wires, &c. Cast steel, refined steel, &c., are exported to Germany. The wealth of Bosnia, in ores, is considered by the *Cologne Gazette*, to be of a character which will, in a short time, give that country a prominent place amongst continental nations in this respect. The railway extension in that district, consequent on the military occupation, has rendered large deposits of ore accessible to commercial enterprise, and the proposed continuation of the Austrian Southern Railway is expected to produce further important results. In addition to iron ore, copper ore, and lead ores, with an admixture of silver, Bosnia contains rich supplies of slate, wood, coal, fire-clay, &c. Quartz and smoky topaz are found. The products of Croatia are also represented in the display at Trieste.

EXPORTS OF TEXTILE GOODS TO MEXICO.—It is stated that in 1880 the total amount of exports from England to Mexico was about £575,000. Rather more than one half of this amount consisted of prints, and about three-eighths was composed of grey and white shirtings, &c. In alpacas, baréges, lenos, &c., the principal source of supply is England, but Germany comes in for a full share of trade in certain classes of shawls and dress goods. The French cloth industry seems to be more important to Mexican buyers than that of Germany, the wants of the market having been apparently more closely studied by the manufacturers of the former country. The linen trade is not in a flourishing condition in Mexico, as the use of cotton has been on a scale of increasing importance. Most of the supply comes from England and Ireland. German hosiery is imported largely, and has but little opposition from the manufacturers of other countries. In silk goods, French and Swiss articles seem to be preferred to those of German origin. The producers of Germany now attach great importance to transoceanic commerce as a means of stimulating industrial activity at home, and are making considerable exertions to obtain increased trade.

MEETINGS OF THE SOCIETY.

Wednesday evening at Eight o'clock :—

DECEMBER 20.—"The Utilisation of Waste. A Quarter of a Century's Progress." By P. L. SIMMONDS.

For meetings after Christmas :—

"Some Points in the Practice of the American Patent Office." By SIR FREDERICK BRAMWELL, F.R.S.

"The Modern Lathe." By J. H. EVANS.

"The History of the Pianoforte." By A. J. HIPKINS.

"Technical Aspects of Lignification." By C. F. CROSS, F.C.S.

"Self-purification of River Waters." By W. N. HARTLEY, F.R.S.E.

"On The Application of Electrolysis to Bleaching and Printing." By JAMES J. DOBBIE, D.Sc., and JOHN HUTCHINSON.

"On the District East of the Caspian." By EDMOND O'DONOVAN.

"The Electrical Transmission of Power." By PROF. GEORGE FORBES.

"Egypt: Present and to Come." By ROBERT W. FELKIN.

"New Zealand." By W. DELISLE HAY.

"The Sanitary Inspection of Houses." By W. K. BURTON.

"Private Enterprise in India." By J. M. MACLEAN.

"Some Notes on the Domestic Architecture of India." By C. PURDON CLARKE.

"The Formation of Diastase from Grain by Moulds." By R. W. ATKINSON, B.Sc.

"Recent Improvements in Agricultural Machinery." By D. PIDGEON.

"English and Foreign Silver Work; with Some Remarks on Hall-marking and its Advantages." By WILFRED CRIPPS, F.S.A.

"Overland Commercial Communication between India and China, *viâ* Assam." By CHARLES H. LEPPER.

"Agriculture in Lower Bengal; with a Notice of Tenant Right, &c." By W. S. SETON-KARR.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Silvanus Thompson, "Dynamo-Electric Machinery." (Lecture III.)

British Architects, 9, Conduit-street, W., 8 p.m.

Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr. G. H. Ryan, "Extra Risks Considered in Relation to a Hypothetical Table of Mortality Based on the H^M Table."

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 3 p.m. Mr. Arthur Lillie, "Buddhism in Ceylon."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. W. Creswick, "Shakespeare and Lytton."

Surveyor's Institution, 12, Great George-street, 8 p.m. Mr. E. Janson, "The Practice of Discounting the Value of Estates in Reversion."

TUESDAY, DEC. 19...Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Annual General Meeting of Corporate Members only, to receive the Annual Report and elect the Council for the ensuing year.

Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m.

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Prof. Flower, "The Whales of the Genus *Hyperoodon*." 2. Mr. D. Gray, "Notes on the Characters and Habits of the Bottle-nosed Whales." 3. Mr. P. Herbert Carpenter, "The Classification of the *Cometulæ*."

WEDNESDAY, DEC. 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Peter Lund Simmonds, "The Utilisation of Waste. A Quarter of a Century's Progress."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Hon. R. Abercromby and Mr. W. Marriott, "Popular Weather Prognostics." 2. Rev. T. A. Preston, "Report on the Phenological Observations for 1882." 3. Mr. J. S. Dyason will exhibit (1) a series of Typical Clouds in Monochrome, and (2) a series of Sketches of Clouds in colour made in June, July, and August, 1882.

Geological, Burlington-house, W., 8 p.m. 1. Prof. R. Owen, "Generic Characters in the Order *Sauropterygia*." 2. Rev. A. Irving, "The Origin of Valley-Lakes, with especial reference to the Lakes of the Northern Alps."

Institute of Bankers, in the Theatre of the London Institution, Finsbury-circus, E.C., 6 p.m. Mr W. Fowler, M.P., "The Circulation of Notes under £5."

THURSDAY, DEC. 21...Royal, Burlington-house, W., 4½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. T. H. Corry, "Floral Development and Mode of Fertilisation of *Asclepias cornuta*." 2. Dr. F. Day, "Observations on the Marine Fauna of the East Coast of Scotland." 3. Mr. J. G. Baker, "Flora of Madagascar." (II.) 4. Prof. Cobbold, "*Ligula Mansoni*, a new Human Cestode."

Chemical, Burlington-house, W., 8 p.m. 1. W. H. Perkin, jun., "The Condensation Products of Oenanthol." (Part II.) 2. Mr. W. Forster, "The Behaviour of the Nitrogen of Coal during Destructive Distillation, with Observations on the Estimation of Nitrogen in Coal." 3. Messrs. E. J. Mills and Jokichi Takamine, "The Absorption of Weak Reagents by Cotton, Silk, and Wool;" 4. Dr. W. H. Perkin, "Note on Nitrobenzyl Cyanide, and some Derivatives."

London Institution, Finsbury-circus, E.C., 7 p.m. Prof. L. Miall, "Some Dominant Forms of Animal Life."

Royal Historical, 22, Albemarle-street, W., 8 p.m.

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. R. E. Middleton, "Portland Cement."

FRIDAY, DEC. 22...Society of Engineers, 6, Westminster-chambers, S.W., 7½ p.m. Mr. Henry Adams "Strains in Ironwork." (Lecture III.)

Quekett Microscopical Club, University College, W.C., 8 p.m.

Journal of the Society of Arts.

No. 1,570. Vol. XXX.

FRIDAY, DECEMBER 22, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

The usual short course of lectures, adapted for a juvenile audience, will be given on Wednesday evenings, January 3rd and 10th, by Professor Henry Nottidge Moseley, M.A., F.R.S., on the "Inhabitants of the Ocean." The lectures will commence at seven o'clock. Nearly all the tickets having now been disposed of, the issue will be stopped on Wednesday next. As all the available accommodation will be required for those members who have applied for tickets, it will be understood that no member can be admitted without a ticket.

CANTOR LECTURES.

The third and concluding lecture of the first course on "Dynamo-Electric Machinery," was delivered by Professor Silvanus P. Thompson, D.Sc., on Monday evening, the 17th inst., the subject being the Dynamo as a Motor. Mr. Anthony Reckenzaun kindly lent a De Meritens motor and a Reckenzaun motor; and the Edison Electric Light Company an Edison dynamo machine, to illustrate the lecture. At the conclusion of the lecture, a cordial vote of thanks to Professor Thompson was carried, on the proposition of Dr. C. W. Siemens, F.R.S., Chairman of the Council.

The publication of the Lectures will be commenced in the next number of the *Journal*.

Proceedings of the Society.

SIXTH ORDINARY MEETING.

Wednesday, December 20, 1882; Hyde Clarke in the chair.

The following candidates were proposed for election as members of the Society:—

Bruce, Sir Henry Stuart, M.A., Glenelly, Bournemouth, Hants.
Byrne, L. H., Brighouse, Yorks.
Cotton, William F., Mountainville, Dundrum, Co. Dublin.
Harrison, Colonel Richard, R.E., C.B., United Service Club, Pall-mall, S.W.
Mackenzie, James Kenneth Douglas, 27, Sussex-gardens, Hyde-park, W.
Smith, Frederick John, B.A., Mary-street-house, Taunton.

The following candidates were balloted for and duly elected members of the Society:—

Aubertin, John James, 33, Duke-street, St. James's, S.W.
Bayly, Robert, J.P., Torr-grove, Plymouth.
Cater, William, 54, Wiltshire-road, Brixton, S.W.
Goolden, George Barnet, R.N., Travers College, Windsor.
Knight, John James, Farnworth, near Wigan, Lancashire.
Stone, William Henry, M.B., F.R.C.P., 14, Dean's-yard, Westminster, S.W.

The paper read was—

THE UTILISATION OF WASTE: A QUARTER OF A CENTURY'S PROGRESS.

By P. L. Simmonds.

I may perhaps be deemed egotistical in bringing forward a hackneyed subject—one which I have often discussed before this Society—but in the long lapse of years, in some of its features, it may be new to the present audience. As in a business point of view, stock-taking is an important feature, I cannot but think it will be curious and useful to ascertain the progress that has been made in many of the important branches to which I directed attention, since I first introduced this subject to the Society, twenty-eight years ago. I propose to classify the informatiou I have to deal with under the three broad divisions of animal, vegetable, and mineral.

In the last quarter of a century, very important progress has been made in our home industries and foreign commerce; but certainly

the success that has been effected in the utilising of waste products, and developing neglected ones, is not the least remarkable of recent scientific advances.

It is evident that, when considered from the point of view of industrial science, the phrase, "utilisation of waste," may be fairly applied not only to the unused residual products of manufactures, but to the boundless, undeveloped wealth of nature. The beautiful aniline dye, produced from the tar of the gas works, is not more an example of the utilisation of waste than beet-root sugar, obtained from what, a century ago ,was a weed growing by the sea-side. Nature produces, abundantly and spontaneously, in many countries, vegetable substances (such, for instance, as the esparto grass), which were long allowed to run to waste. Important industrial uses have been found for many of them, and fortunes realised by numbers who have turned their attention towards rendering them articles of commerce.

Animal Waste.

The flesh of domestic animals fit for food is almost a waste substance in many countries, since it cannot be locally consumed nor profitably preserved. In the River Plate Republics alone there are 80,000,000 sheep and 25,000,000 cattle to a population of 2,500,000. For years sheep were only valued there for their wool, and when flayed, carcases were left to rot, or, when dried in the sun, piled up in stacks for fuel, while later on they were boiled down for their tallow. Sheep get very fat in the province of Buenos Ayres, and those of three and four years will give frequently from 18 to 25 lbs. of tallow. Countless numbers of sheep are boiled down every year in the so-called "graserias," only for the tallow, which forms one of the staple articles of export. The mutton is thrown away, or used in a dry state as fuel.

I alluded in my first paper to the countless herds of so-called buffaloes, the bisons, which were hunted in the prairies of North America, chiefly for their skins or furry "robes." At least half a million were killed yearly, but of late the flesh and the bones have been collected and utilised. A recent law of the United States, however, prevents the wholesale slaughter of these noble animals, for fear of the utter extermination of the breed.

In the five years ending with 1850, more than one million and a-half of sheep, and 200,000 horned cattle, were boiled down simply for their tallow, in the colonies of New South Wales and Victoria.

We are great meat-eaters in this country, our average consumption being 120 lbs. per head, or double that of the people on the Continent; and as our home supply is quite insufficient, we have to import more than 600,000 tons every year. With the growth of our population, and the decreasing number of live stock at home, the imports of meat from abroad have prodigiously increased in the last quarter of a century. In 1856 our imports, including fresh and salt meats, hams and bacon, and live cattle, were only of the value of £3,233,587, whilst in 1881 they had risen to £24,754,000.

In a paper read before the Royal Colonial Institute last month, by Sir Francis Bell, the Agent-General for New Zealand, he stated that frozen meat in any quantity can be placed upon this market from the other side of the world at 6d. to 6½d. a lb., leaving a good profit to the grower. "This (he added) ought ultimately to make meat cheaper here, or at least prevent the further rise now threatened. Australia and New Zealand can, in fact, export 700,000 tons of meat a year, or 2,000 tons a day, which is not much more than you want in England even now, without reducing even the present capital number of their sheep and cattle; and we are able to send on sheep to Smithfield with greater ease to-day than the Tweed farmers could 100 years ago, when meat was selling at a penny a pound in Scotland against tenpence in London."

Horses, although numerous in some countries, as in Russia, and the River Plate States, have not been, commercially, very useful when dead. In South America mares are never broken to the saddle, and the carcases are generally boiled down for their fat, the exports of mares' grease being considerable, while the hide is also useful. But, within the period now under our notice, horseflesh has come largely into use on the Continent for human food.

Since 1860, when the first slaughtering of horses for food took place in Paris, under the patronage of the "Society for Promoting the use of Horseflesh," the consumption of this meat has been steadily increasing. The sale of horseflesh has become a legalised and and recognised trade in many of the continental States, especially in France and Germany. The published statistics of that society show that, since its foundation in July, 1866, 160,080 horses, 6,690 donkeys, and 395 mules, had been sold in Paris alone for food, up to the end of 1881, furnishing 67,809,460 lbs. of meat. Horseflesh is sold at half the price of beef. The in-

novation has gained ground rapidly in most of the principal towns of France, and the public sale of horseflesh for human food is now general in Austria, Prussia, Bohemia, Saxony, Hanover, Switzerland, Belgium, and Sweden. In this country we are more fastidious in our eating, and although efforts have been made to introduce horseflesh as food, they have not succeeded. The hundreds of horses which die in the metropolis are sent, with other carcases, to special firms, which utilise every part commercially. The skin is removed, and the bones are taken out with great expedition; the flesh is then placed in cauldrons, of a capacity of 600 gallons. Upon boiling the flesh, the oil is separated, and used by soap-makers and leather-dressers. The bones are also boiled, yielding further oil and fat, and are afterwards utilised for manure.

In the United States, there was formerly a plethora of waste. The time was when, in Cincinnati, Chicago, and other slaughtering centres, the food of millions was cast out, and allowed to be entirely lost by being thrown into the river, or burnt in large pits. Several years ago, one of the most extensive slaughterers asserted—and he had good reason for knowing—that in Cincinnati as much was wasted in one day during an active season as would feed all the inhabitants of Paris for a week. At that time, indeed, all the heads, feet, intestines, and much of the lard of the hogs, were cast out. Now, such is not the case, for the poor but industrious German and Irish populations have saved much of this extravagant waste, and, by their cheaper labour, almost the whole of these substances has been converted to profitable use. Even now a great deal of the ox is disused, which in Europe is esteemed most nutritious food. One cannot obtain in America a bowl of ox-tail soup in private houses, and very seldom in hotels and restaurants. It costs too much labour to separate the rich gelatinous tail from the hide. Ox tripe is sold in the Cincinnati markets, but the liver and heart are most frequently buried, or allowed to be swept away with the blood. And the blood of the tens of thousands of cattle, and hundreds of thousands of hogs, each season slaughtered, is never saved, but runs down the open gutters, until it mingles with the water in the river.

There is an important industry which has sprung up out of animal waste, in the utilisation of purified tallow and other fats for food and domestic purposes. It was originated in France in 1869 by Mons. Mége, and was intended for the manufacture of artificial butter from fat, by extracting the oil at a low temperature, and converting this, by churning, into butter. It was first known as oleomargarine, then as margarine, and latterly as butterine. The manufacture of this product has spread extensively, and it is carried on in the United States on a very large scale. As a London trade journal observed, a few weeks ago, "It is to be regretted that shopkeepers do not see their way to offer it to the public under its proper name, a proceeding which would be not only more honest, but which would ultimately tend to the more general adoption of butterine as an article of daily consumption."

From statistics prepared by Mr. Nimmo, of the United States Department of Agriculture, it appears that more than one-third of the American exports of butter are sworn to be oleomargarine. Now, as we receive over 8,700 tons of so-called butter from North America, it is not pleasant to know that one-third of this is the artificial butterine. Not only is margarine thus used, but, under the name of sueine, much lard is now introduced into the butter.

In the utilising of inferior or waste materials, and in the separating of tallow from the substances with which it is found in combination, machines are employed which are both ingenious and effective, and by their use much material that would otherwise be worse than useless is turned to good account.

In Europe, rabbits are not a waste substance, but are eagerly sought for as food, and even bred in large quantities; but their introduction into Australia and New Zealand has proved an unmitigated evil to the colonists. About twenty years ago there was not a single rabbit in Australia, save perhaps a few domesticated pets. Since their introduction, they have become a perfect pest, and the difficulty is to exterminate and keep them down by poison, dogs, &c.

From New Zealand alone eight and a half millions of rabbit skins were exported in 1880, but this does not probably represent one-tenth part of those actually destroyed. In that climate the rabbit breeds nearly every month in the year. But even supposing that a pair of rabbits do not breed oftener than in England, which is seven times a year, and that they only bring eight young at a time, they would multiply in the course of four years to a million and a quarter. Besides the skins shipped to England and America, the colonists are trying to send us their flesh in tins.

Rabbit skins are in demand by the furrier. About thirty million indigenous rabbit skins,

and two or three million hare skins are used up in this country. The skins of those which are not used or dyed as furs, are, after the hair has been pulled for the hat-maker and for stuffing beds, employed for glove making. The hair is also now used for making yarn and cloth.

The wool manufacture, in almost all countries, now uses up cuttings of cloth and shreds of all kinds which were formerly thrown away. These, and the strippings and waste in carding, are now classed immediately after pure wool, and command relatively high prices.

There are many who may be disposed to regard the shoddy manufacture as a business to be despised, but the political economist discovers in it a most important source of wealth —wealth resulting from the application of skilled labour to the utilisation of material once worthless, but now contributing no mean sums annually to the wealth of nations. The shoddy manufacture would seem to have originated at Batley and Dewsbury about fifty years ago. It was only in 1861 that we commenced to import woollen rags, about 7,000 tons being received. In 1881, the imports were 35,000 tons, valued at £701,000. There are two distinct terms used in the rag-wool industry, (1) "shoddy," which is the product of soft woollen rags, such as stockings, flannels, shawls, &c., torn by machinery into fibre, suitable, when mixed in certain proportions with wool or cotton, or both together, to be re-spun into cloth; (2) "mungo," which is a variety of the same material, firmer, but much shorter in staple, obtained from hard woollens, such as broadcloths, tailors' clippings, &c., The average price of shoddy is about 4d. per lb., and that of mungo, about 6d. Noils and waste are obtained principally from Bradford, where spinning and power-loom waste are produced in considerable quantities, and though refuse in the Bradford trade, they serve a useful purpose in the shoddy manufacture. There is a third product utilised, known as "extract wool," which is obtained by a chemical process which destroys the cotton in union or mixed fabrics, leaving the wool uninjured. This process of destroying the cotton by the use of acids was discovered about twenty years ago, and is carried on both in Great Britain and the United States.

There are now 137 shoddy factories, principally situated in the Yorkshire district, which employ over 5,000 persons, 3,000 of whom are females. About 40,000 tons of woollen rags are annually torn into shoddy in England alone, and the quantity made in the United States must be almost equal. No accurate data can be found of the European use of these articles, but an immense quantity of both shoddy and mungo is now made and exported from the Continent, principally to England, and it is probable that the whole of the world's annual consumption is over £7,000,000. in value. At the recent International Wool Exhibition, held at the Crystal Palace under my charge, there were shoddies sent from most of the States of Europe. Italy first began to work woollen rags into yarn, in 1858, and most of the other European countries followed the example.

Let us pass to another important manufacture—silk. Nine years ago, in an article in the *Journal*, I drew prominent attention to the increasing employment of silk-waste, and I, therefore, need not go into any very full details. But still the subject deserves passing notice, from the trade importance it has attained. Raw silk having become scarce and dear of late years, much more attention has been given to the employment of the different sorts of silk waste, for which, at one time, scarcely any use could be found.

The variety of these is very large, and most of them are now profitably and extensively employed. The outside and inside husks of the cocoons used to be mere refuse. These pass under various trade names in different countries; in England, as "knubs and husks" and "floss silk;" on the Continent as "*bourre de soie*," "*frisonets*," and "*floret*." What is termed "yarn waste," is the waste made by the silk throwster. The pierced cocoons, that have been eaten through by the moths, are now largely employed in the preparation of "chappe," or "schappe." Then there is the noils and thread waste from the silk factories.

In 1857, the imports of these waste silks were only 18,000 cwt., valued at £302,286. In 1881, the imports reached 540,119 cwt., valued at £757,796. France, Switzerland, Germany, Great Britain, and the United States have now entered extensively into the utilisation of silk waste for manufactures, which was formerly a drug in the market. In the Swiss report on the Paris Exhibition of 1867, it was stated that the annual production of floss silk yarns then ranged in value from £400,000 to £600,000. In 1872, about 7,750,000 lbs. of thread were made from waste silk in Europe. In the United States, 2,000 to 3,000 bales of waste silk are used up annually, valued at £200,000. Italy exports annually about 5,000,000 lbs. of silk

waste. At Manningham, near Bradford, Messrs. Lister and Co. have one of the largest silk factories in Europe, chiefly engaged in manufacturing articles out of waste silk that are scarcely, if at all, made elsewhere in England, such as velvets, hat plush, and ribbon velvets.

There are 15 establishments in France, with 479,353 spindles, working up waste silk, that is, the waste from the cocoon not reelable, the short pieces, &c. What remains over from this working is again used up by seven other factories, which by means of further combing and carding, employ waste formerly only partially utilised or altogether lost to consumption.

In connection with this subject, I may draw attention to the stimulus given to the collection of the cocoons of the wild silk-worm of India, known under the name of Tusser. These, which were formerly only used in the East for making a kind of drab or coffee-coloured silk, have now, through the exertions of the Indian Government, and the skill of Mr. T. Wardle, of Leek, been made to take dyes, and are profitably employed in the silk manufacture in England. The waste of the wild cocoons in China and Japan is made into felt for hats, and enters into the manufacture of paper.

The improvements in machinery for the preparation and spinning of silk waste have made great strides of late, and whereas a few years ago one never heard of anything but "spun silk" hosiery, handkerchiefs, or some other little article of similar make, the whole world now knows the "schappe" velvets of Crefeld, the "spun" ribbons of Basle, and the laces of Nottingham, while the king of silk spinners—Lister of Manningham—has even produced machine-twist of excellent quality from this unlikely material.

Let us look at the supply of raw material, and compare the facilities of twenty-five years ago with those of to-day. Then the European spinners had simply the choice of Canton gum waste, China curlies, Bengal chassum, Persian balls, or Italian knubs and gum, with what little engine-waste he could obtain from the throwsters of China raw silk here. This last, indeed, was often so lightly valued by the owner of the throwing mill, that the operatives were allowed to use it for cleaning machinery. Now we find that Japan alone furnishes at least four well-known kinds, pierced cocoons, knubs or curlies, the inferior outside layers of the cocoon, winders' waste, and floss silk, known among merchants as "caps," being the sheets used to protect the ends of the books or bundles of silk.* The export of this silk-waste from Japan exceeds 27,500 cwts.

The refuse from the tanneries, now so profitably utilised, is of considerable importance; it consists of untanned dried pelt or glue pieces, fleshings, hair, lime deposit, and spent-tan. Glue pieces or "scrolls," as they are termed, are sold to the paper-maker, and scores of tons for the manufacture of gelatine and portable soups. Ordinary size is made from the flesh refuse of the hide, and is extensively used by paper-hangers, cotton-spinners (to give firmness to the thread), and carpet manufacturers. One firm of tanners makes £1,000 a year out of their fleshings from hides. Ladies may be interested in knowing that the so-called cheap seal-skins are manufactured in the North of England from common plasterers' hair, or that obtained from the tan-pits. The spent-tan or bark—about 250,000 tons—has not yet found very profitable use. Some have tried to turn it into charcoal, and light their tanneries with its gas, but with slender success. Liebig has shown that both this and the lime-grounds or deposit are useful as manure. There has been made for many years, in Germany, printing-paper and cardboard of the waste bark from tanneries. The common papers receive about 10 or 15 per cent. of this pulp; the boards for roofing from 20 to 40 per cent.

Artificial leather is also now extensively made from leather cuttings, pressed and rolled into sheets with some glutinous composition.

Latterly, it has been found that leather waste-cuttings, &c., when steamed with certain waste liquors, produce a valuable material in the shape of a new black, which is destined to have a variety of important uses, such as in the manufacture of printing inks, dark pigments, covering substances, and notably for the manufacture of blacking. Bone-black, from which the latter is chiefly made, costs £9 per ton, and the supply is limited, whilst this new tannic black can be sold at one-third of the price.

The blood from the slaughter-houses, which used to be wasted, is now collected in Europe, and utilised for manufacturing into blood albumen, which sells at about 1s. a pound. The drainings and the clot go for manure. In France, the quantity of blood resulting from the animals slaughtered is estimated at 177,000 tons; but they do not yet utilise it so generally

* *Japan Weekly Mail.*

and advantageously as we do, it being chiefly employed as a fertiliser for land. In Spain, the quantity of blood from animals killed reaches half the quantity named for France.

Among the miscellaneous animal substances now utilised, we find many species of fish skin tanned, such as the so-called porpoise skin (*Beluga catodon*). Alligators and crocodiles, and even snakes, are hunted for their skins, which are tanned, and provide a valuable article in making slippers, purses, pocket-books, cigar-cases, &c. One tanner at St. Louis, America, is stated to have received recently 5,000 alligators' skins.

Great progress has been made in the period under review in the manure trade, both as regards natural and artificial fertilisers. In a recent official report made to the French Legislature, the trade in manures in that country was valued at £3,000,000. In England, it would be very much more. We do not receive so much guano as formerly, for whilst in 1840 the imports were from 250,000 to 300,000 annually, they have now dropped to about one-fifth of this amount.

In view of this deficient supply, we are obliged to look to other sources. Thus, our imports of bones and other substances used for manure were, last year, of the value of £1,565,801. A large trade is done in artificial manures sent to the north of Europe, our sugar-producing colonies, and the Cape of Good Hope.

Even in Australia, the large accumulation of bones and other animal refuse from butchers', boiling-down, and meat-preserving establishments, has led to the creation of extensive factories, for converting these waste products into valuable fertilisers. The manufacture of these artificial manures is now conducted on a very large scale, and a considerable local and export trade has resulted therefrom.

Vegetable Waste.

Let us pass now to vegetable substances, and I will first consider the paper manufacture. A recent estimate was published, which set down the paper mills of the world at 4,000, producing 1,000,000 tons of paper, of which the half was used for printing.

The quantity of paper of different kinds now made in the United Kingdom probably exceeds 350 million pounds annually. The newspaper press alone has made enormous strides, to say nothing of books, periodicals, and other printing demands. A quarter of a century ago, there were scarcely twenty or thirty daily issues of newspapers in the Kingdom; now there are at least 140, many of them papers with very large circulations.

In 1856, we received but 10,284 tons of rags for paper-making from abroad; in 1881, we imported 26,773 tons. Esparto grass was only introduced to any extent in 1861, when 891 were received. In 1881, the imports had risen to 192,493 tons, valued at £1,286,211. Besides this, we also imported 45,550 tons of wood-pulp and other paper-making substances.

It is now evident that the future of the paper industry will, in a large degree, depend upon the use of wood, which is already so extensively employed. For the ordinary varieties of paper, ground wood is used; but for the finer sorts, chemically prepared wood-fibre, or cellulose, is employed. The practical process for the preparation of cellulose was discovered in 1852, and numerous other processes or improvements have since been invented. It comes into commerce in two forms—wood-pulp in sheets or blocks, and ligneous meal or wood flour.

In Central Russia, aspen wood is most extensively employed; in Sweden and Finland, spruce and fir, which afford the longest fibres; in Germany, France, and Belgium, mixed woods. The pulp from beech and birch woods has too short a fibre.

About twenty years ago, some of the American papers used the bamboo largely for making paper. This is no new application, for the Chinese have long employed it for a common description of paper. Of late years, however, Mr. Thomas Routledge, of the Ford paper mills, Newcastle, who was the first to utilise extensively esparto grass, has prosecuted extensive researches and inquiries, so as to extend the supply of this excellent paper material. It may be mentioned here, that the number of the Society's *Journal* (Nov. 28, 1856) containing Dr. Royle's paper on Indian fibres, was printed on paper made by Mr. Routledge, entirely of esparto.

The fibrous stem and leaves of the plantain, which is so plentiful in most tropical regions, have not yet been practically utilised, although efforts were made some years ago in British Guiana by a company. Dr. King, the Colonial Botanist at Calcutta, recently reported:—"It has been found that, during the dry months, simple exposure of the sliced stems to the sun is sufficient to prepare the fibre for paper-making, provided the paper mill be on the spot. What is still wanted is some cheap mode of removing the cellular tissue, so that the fibre

may be shipped to England without the risk of fermentation on the voyage."

A good deal of the jute sent from India to the United States consists of the dark root, or butt-ends of the fibre, which are cut off when the jute is pressed into bales. These are called "cuttings" in Calcutta, and with us, "rejections;" they now form a regularly quoted article of export to America, where they are employed in the fabrication of various shoddy-stuffs. In former years these cuttings were thrown away.

The *Dundee Advertiser* of the 14th May, 1873, was printed on paper made from jute, and in the issue it was stated:—"This is the first paper, as far as we are aware, ever printed on jute. Being in the centre of the jute manufacturing district, we have been anxious, for some time, to print on the material which has now become the staple of our local manufactures, and we are indebted to our principal paper-maker, Mr. D. M. Watson, of Bullionfield, for carrying out our wishes. It may be explained that this sample is made almost entirely from old jute bagging." To some extent, jute bagging and waste have now been used by paper-makers for several years.

Other waste substances are coming into use with the paper trade, where obtainable in quantity and cheap. Megass, the refuse stalk of the sugar-cane, makes excellent paper. The husks of oats, barley, rye, and rice, are also used alone, or combined with other materials.

Straw-board, of late years, has been found to be a cheaper material than the old-fashioned "pasteboard," and it has come extensively into use in America for paper boxes. The annual product of straw-board in the States is from 35,000 to 40,000 tons.

Straw has long been employed as a paper material, but it is often scarce and dear. It is even found profitable to buy up the bedding litter from the metropolitan stables, and, after washing and disinfecting it, to sell it to the paper mills. The last United States census (1880) showed that more than 270,000 tons of straw were used for paper.*

By the patent process of Chadwick and Clench, the carbonate of soda is recovered from the waste liquors, resulting in the reduction of fibrous materials, when manufacturing paper pulp from straw, esparto grass, hemp, jute, and other fibrous materials.

In a paper read last year before the Scottish Society of Arts, by Mr. G. J. Wishart, on the recovery of soda from the spent lye of the paper-maker, he observed:—

"The industrial progress of recent years has in no direction been more marked than in the utilisation of waste materials. New industries have thus been created, and old ones rendered more profitable, while grave public nuisances have, in many cases, been removed or abated.

"Were it not for the bye-products obtained from what was once considered waste in the manufacture of paraffin oil, it would be impossible for the manufactured oil of this country to compete with the ready-made article of the American wells. By a similar utilisation, gas—the product primarily sought for in the distillation of cannel coal—can, it is said, be manufactured free of cost; while, in the paper industry, the chemicals employed in the process of converting esparto and other raw fibrous substances into paper pulp are now, to a large extent, recovered, and are thus kept out of the streams they formerly polluted, to the manifest profit of the manufacturer, and the satisfaction—so far—of riparian proprietors."

Until a very recent period, the waste paper of the Government offices of London was the perquisite of the messengers. But when it was found that the aggregate sales of this waste paper reached the sum of £10,000 to £15,000 a year, it was thought time to look into this, and it was then handed over to the Stationery-office, and, in the last financial year, the sale of waste paper reached £11,771. Unfortunately the Government printing is very lavish, every member receiving about a ton weight of Parliamentary documents yearly. The United States Treasury sells yearly more than 600 tons of paper pulp, resulting from the destruction by maceration of Government securities, bank-notes, &c.

In one large printing and publishing establishment in the metropolis, the waste paper in shavings and imperfect impressions exceeds 75 tons a year. Even the newspaper offices now economise and use up their spoiled impressions or overplus papers for printing their posters on.

I might enlarge upon the extension of the trade in fibrous substances, formerly waste, used for brushmaking, such as kittool, piassaba, Mexican grass, &c.; but there is a gentleman present who can supply better

* The whole materials used were:—

	lbs.
Straw	540,843,600
Rags	413,417,400
Old paper	193,248,000
Manilla stock	186,529,200
Cotton-waste	26,593,600
Corn (maize) stock	2,098,100
Esparto grass	580,800
	1,363,311,400

This is inclusive of the wood-pulp consumed.

nformation, as he was the first to introduce them.

It is only since 1860 that the extraction of the oil from cotton seed has been carried on on a commercial scale; before that date vast quantities of the seed were allowed to accumulate and to rot on the cotton plantations. It is an industrial fact of considerable interest and significance, that at the present time the seed is often more valuable to the planters for its oil and oil-cake than the cotton fibre, for of the latter it contains only about one quarter of its weight.

Decorticated cotton cake, largely used for cattle food, is of a pure yellow, and is made only in England and America. The seeds are crushed in the decorticators, and the husks removed from the kernels by winnowing. The kernels are next ground and made into cake in the usual way. The husks are utilised in paper-making. If the oil is to be used for industrial purposes, the cakes are hot-pressed; but oil for table use is always obtained by pressing in the cold.

The total production of cotton seed in the United States has been estimated at more than two and a-quarter million tons, but there are other sources from whence supplies are drawn, such as Egypt, Brazil, and India. Not many years ago, our imports of cotton seed into the United Kingdom were only 80,000 to 100,000 tons. In 1881, we received over 232,000 tons, of the value of £1,783,109.

In France, large supplies of cotton seed are received from Turkey, Egypt, and Italy. Marseilles and Rouen are the leading towns in which the seed is crushed, and the oil, so expressed, is used by painters, varnish makers, and soap manufacturers; combined with other oils, it is used for lubricating, and now also extensively as a substitute for lard for household purposes.

It is stated, in an American paper, that there are now in operation in the Southern States, sixty-seven cotton oil mills, and the price of cotton seed has advanced from six to twelve dollars per ton. Over £500,000 worth of oil was manufactured last year; this, however, is declared to be but a mere fraction of the value of the whole crop, were it all utilised. The American cotton crop, of last year, produced about three million tons of seed. Of this, no more than 180,000 tons, or one-sixteenth of the whole, were crushed. The 2,800,000 tons which went to waste, would have produced ninety-eight million gallons of crude oil, worth forty cents. per gallon, or more than £8,000,000 in value.

In the process of refining, the residue of the crude oil is distilled, and, with care, produces a hard grease or stearine, which commands, when of good colour, within 3s. or 4s. per cwt., the price of Petersburg tallow. This bye-product is used for making artificial butter. Even the foots, or tarry residue, is useful as a paint ingredient. Cotton seed oil is now largely mixed with olive oil. Its presence may be recognised by treating the oil with nitric acid; on shaking it, a coffee-brown colour will be seen if cotton seed oil is present.

Although the olive is a most important product of Italy, Greece, and some other countries, the means generally employed for extracting the oil were very imperfect, and led to considerable waste of oil. After the olives had been crushed by the peasants, the husks were abandoned as worthless. Until the last seven or eight years, the residue from the oil presses was either used as manure, or more usually burnt as fuel. It was largely exported from Corfu to Malta, where it fetched remunerative prices, being used by the bakers to heat their ovens. The accumulation of this material in the Ionian Islands had become enormous, in spite of the local consumption, when it occurred to some one to analyse it, with the view of turning it to some useful account, and it was then found to contain a large per-centage of useful oil. At Corfu alone, from 350 to 400 tuns of this oil, extracted by bisulphide of carbon, is now shipped to Marseilles, and used for soap-making. The crude product, freed from the nuts, contains about 25 per cent. of fatty matter, and the cake, as received from the press, with the nutshells still in, contains about 13 per cent. of fatty matter. The husks are now imported in large quantities to Marseilles, where, by chemical means and a steam press, 20 per cent. of oil is obtained. The nuts of the olive, which were formerly thrown away, now yield, in Greece alone, oil to the value of £20,000. These improvements have been effected within the last 15 years. At Tunis, small bits of the olive skins, after the oil has been extracted, are mixed with wheat and barley, and made into bread.

On the West Coast of Africa, in the production of palm oil from the fruit or drupes, the kernels were formerly thrown away, now they are cracked by hand with stones by whole villages. In 1863, it was found profitable to collect and ship them for the oil, of which

they yield about 30 per cent. From the single port of Lagos about 45,000 tons of these kernels are shipped, valued at £300,000; from Sierra Leone 10,000 tons, and other quantities from the Gold Coast. It has been estimated by competent authorities that, from the 50,000 tons of palm oil shipped from Africa, there must be 223,000 tons in weight of kernels, which would yield as much more oil as is already shipped. In fact, a competent authority, Mr. C. Sevin, of the "Palm-nut Oil Mills," estimates that we ought soon to get 400,000 tons of palm-nut kernels from West Africa. The marc, or residue after the expression of the oil from nuts and seeds, if not exactly a refuse material, is at least a secondary product in the manufacture, which possesses considerable value, and has become a large article of commerce for feeding stock and manuring land. Among the oil-cakes chiefly used for cattle-food, are linseed, rape-seed, decorticated cotton-seed, ground nut, and cocoa nut;—mustard-cake, rape-cake, castor oil-cake, undecorticated cotton-seed, and some others are used for manure. Besides the quantity of oil-cake made at home, we imported, in 1881, from abroad, 221,100 tons, of the value of £1,764,492.

One of the raw materials, the most abundant in the production of alcohol, is the molasses from beet sugar. The quantity of molasses annually produced on the Continent is estimated at 250 millions of kilogrammes. Of the 30 parts of non-saccharine matter 5½ per cent. are potash, and 1¾ to 2 per cent. of nitrogen. It was only in 1853 that the distillers first entered on the production of alcohol. The molasses, after yielding alcohol, leaves as residue a brown aqueous liquor known as "vinasse." This, evaporated and calcined by heated air in special furnaces, furnishes the saline of beet-root, which is one of the most important sources of potash in France. The pulp of the beet-root is largely used for feeding cattle; its value, however, varies according to the process by which the sugar is extracted. The ordinary process is by pressure, the other by diffusion. In the first case, the roots being submitted to rasping, the cells are torn, and the saline and albuminoid matters are mixed up with the sugar in the juice by the action of the press. In the second case, the cells are preserved intact, the beets being cut into thin slices, which are treated with tepid water. The residues from diffusion are almost free from sugar. If in the dry states, they are more rich in albuminoids. About 5 lbs. of this pulp is given daily to a sheep, and 50 lbs. per head to cattle, in admixture with other food. The pulp is stored for preservation in trenches or silos, and for this purpose it is mixed with about one per cent. its weight of salt, to prevent it from entering into putrefactive fermentation.

There are upwards of 40,000 breweries in the United Kingdom alone, to say nothing of the large numbers on the Continent. The best use of the bye-products of the brewery is that of the grains for cattle-food. As this is very subject to decomposition, various systems and apparatus have been invented to preserve the grains. The old-fashioned plan of pressing them into pits or a large tank, with the addition of some salt, in order to preserve them for a time, is well known; but this is not practicable if the grains have to be carried great distances. In 1874, Mr. Henry Chapman took out a patent in America, for compressing, salting, and drying the grains, and thus making them into a novel and saleable article of commerce. Upwards of three million bushels of malt are brewed in New York and neighbourhood every year, which yield 16,500 tons of dried grains.

The marc, or residue of hops, according to Boussingault and Payen, contains 2⅕ of nitrogen dry, and about ·56 wet. From the residue of distilleries from maize by the filter presses and heated cylinders, a large quantity of burning and saponifiable oil is now obtained, and also feeding cakes for cattle, of equal value to those from earth nuts.

Take another instance of utilisation in dried yeast; not only is it an important article of import with us from the Continent—206,000 cwt., exceeding £542,000 in value—but it has become an extensive industry in many countries. In Russia, the value of the pressed or dried yeast annually consumed is officially stated at 250,000 tons. They also import about 20,000 cwts. to 22,000 cwts. from Germany and Austria; twenty years ago the import was only 10,000 cwts. A dried yeast is also made from maize in Baden, which differs from the rye yeast of Hanover and Hesse, the compressed beer yeast of France, and the dry yeast of Bavaria, in that it keeps better, and contains a more regular ferment, which renders the bread lighter and of a better taste.

There is one product of the United States which, although scarcely a waste one, is very difficult to use up profitably; that is, maize or Indian corn. This staple crop increases so rapidly that use can hardly be found for the whole of it. Its principal application is for fattening

the enormous hog-crop of the States. It has been used for distilling, and for making starch; but recently a profitable employment has been found by converting it into glucose or starch sugar. When we consider that the maize crop of North America exceeded, in 1880, 1,700 million bushels, any new uses for this abundant cereal become important.

In the States of Iowa, Illinois, and Nebraska, there are often thousands, if not millions, of bushels of Indian corn in the ear, that can neither be sold nor fed to stock, and which have to be used as fuel, for want of means of transport to a ready market, for it takes five bushels of corn to pay for sending one bushel to where it can be used.

Mr. Pakenham, the British Secretary of Legation, in his official report for 1873, stated that—

"Between the consumption and exports there is often a surplus of 664 million bushels. Some of this is doubtless utilised, but inquiry from season to season, only elicits the reply that, when not burned, it lies over, deteriorating, and is applied to some inferior purpose, or used for manure."

It would be difficult to define the limits to which the indirect consumption of Indian corn extends. Every pound of American pork eaten, the laundry and food starches used, the large production of alcohol (that of whisky in the States is 67 million gallons), the varnishes used by the cabinet-maker, the perfumery of the toilet table, the different kinds of illuminating fluids, all indicate the universality of the employment of maize.

It was in 1867 that the new use was found for maize, by converting it into glucose. The report of the New York Chamber of Commerce states that the production of this sugar is now not less than 1,000 tons a day for the whole country. A bushel of corn is said to yield thirty pounds of grape sugar, or three gallons of the syrup; and while the sugar costs less than 2d. per pound to make, it is sold at 3½d. and 4d; the syrup being quite as valuable.

In the States, this class of sugar is used most extensively for mixing with cane sugar and cane molasses; while reducing the sweetening power, it produces a whiter and pleasanter appearance in the sugar. Glucose is largely imported into this country, being chiefly used by the brewers, but more recently for confectionery and preserving purposes. Our imports last year of solid and liquid glucose (chiefly from Germany) were nearly 400,000 cwt., valued at £367,000.

In America, they are also endeavouring to utilise the immense quantities of pulp remaining from the corn after the extraction of the starch. This pulp, which is at present a waste product, consists wholly of cellulose or woody fibre, and would, it is considered, be an excellent material for making the commoner grades of paper, suitable for wrapping and newspaper purposes.

Potash is a valuable product, obtained from the destruction of wood. Canada used to supply us with large quantities, but her exports have fallen off by one-third. We only received, in 1881, 60,000 cwt. of potash from all quarters; 16,000 tons used to be made, annually, in the United States, but there is not, now, such an extensive destruction of forests. Throughout Australia, although thousands of tons of timber are burnt annually, the ashes are never lixiviated for the purpose of obtaining potash.

The present sources of the supply of potash are rapidly failing; every year the area of the supply becomes smaller, and the product, in consequence of this and the increased demand, becomes more and more expensive.

The cobs of Indian corn, which are now considered of little or no value, may yet share the same fate as many substances which, though formerly considered worthless, have become new mines of wealth, through the aid of chemistry.

The average yield of 1,000 parts of cobs is 7·62 parts of carbonate of potash, or nearly twice as much as the best specimens of wood, and it is a material which can fill its full measure of usefulness for other purposes, before it comes into the hands of the manufacturer of potash. At the shipping ports, large shelling mills are established, capable of running through 500 bushels of corn an hour. Here, then, are the places where a supply of cobs may be procured.

The corn crop of North America varies; but, taking the yield of 1871—1,100 million bushels, at 14 lbs. of cobs to the bushel—this would yield 7,700,000 tons of cobs, containing an average of three-quarters per cent. of pure carbonate of potash. The enormous quantity of 115½ million pounds of that useful article might thus be thrown into commerce. In some districts, these corn cobs are extensively used as fire-lighters, being dipped into a composition of resin and tar, and then dried.

It is only some twenty years now since glycerine, a bye-product in the manufacture of soap and candles, has been produced on a commercial scale, but the quantity now made represents

an annual value of nearly a quarter of a million sterling. Glycerine has thus attained to a position of considerable technical importance. The introduction of the stearine candle industry, and the efforts to utilise the heretofore waste products of the soap manufacture, demonstrated its existence in considerable quantity. The important uses to which this substance is now applied are so numerous, that it would be difficult to enumerate them. There are no available statistics to estimate the total magnitude of the glycerine industry of the world, but its extent may be imagined from the fact that, in the United States alone, there is annually produced not less than two million pounds, and in Europe, as is said, about 520,000 cwts.

There is a large consumption of cork bark, in this and other countries (the quantity we import exceeds in value half-a-million sterling), and even in this direction, the economising of the waste is found profitable and useful. The suberine powder is made into cork carpets for floor-cloth, and it is even used by chemists in place of lycopodium, powdered rice, starch, &c. Old corks are collected, and cleaned with hydrochloric acid and hot water, so as to be used again. The Paris sewers are provided with gratings, and the corks thus collected are re-cut, and used again. All cork cuttings are useful for filling life buoys, belts, jackets, and even beds.

In Europe, as much use has not been made of seaweed as in China and Japan, where it forms a very large article of consumption for food. In China, it is imported both from Japan and Asiatic Russia, to the extent of more than 25,000 tons a-year. It is received in two forms:—1st quality, cut, and some known as agar agar; and 2nd quality, long. This seaweed is principally consumed by the lower classes of Chinese as a condiment or flavouring, with their rice or other food.

Another product into which seaweed is converted is gelose, a sort of vegetable isinglass. Viewed from whatever direction, the more general utilisation of seaweed is a most important matter. In some of the northern countries of Europe, cattle are fed on it. Formerly, iodine was only obtained in any quantity from the kelp of seaweed, but it now appears likely that it can be produced in Peru at a comparatively small cost, being a bye-product extracted during the process of manufacturing nitrate of soda; whilst the necessary arrangements for the manufacture of iodine from kelp are very costly, and the works and machinery used require a large sum of money. It is possible that 5,000 or 6,000 cwt. of iodine might be manufactured in Peru at a low cost, but the war with Chili interfered materially with the production. With the exception of the manufacture of kelp, the principal use of seaweed is for manuring land. Under the name of carrageen, or Irish moss, some is used for food. In France, a gelatine or gum is prepared from seaweed, which is variously useful in the arts, as in finishing cotton fabrics, making artificial leather, &c. When chemically prepared and pressed, it was, at one time, used extensively for the manufacture of a substitute for horn, called laminite, but this has been dropped. It has occasionally been made into paper.

There is an application of waste substances of vegetable origin that is largely carried on, which certainly does not merit approval, being, for the most part, prosecuted for the purposes of deception and fraudulent gain, and this is in substitutes for, or additions to, coffee. Figs, date-stones, lupines, malt, chicory, &c., are largely sold, besides the seeds of a stinking weed *(Cassia occidentalis)* which, when roasted, according to French authorities, is equal to coffee. Whilst the production of coffee is fully equal to the demand, and the price is moderate, I cannot see the necessity for these various substitutes. The more legitimate use of date stones is that to which they are put by the Arabs. They are soaked in water for two or three days, and when somewhat softened, used to feed their camels, cows, and sheep. There are shops in Medina where they sell only date-stones, and the poor often occupy themselves in collecting the date-stones thrown about the streets by those who eat dates.

Ineffectual attempts have been made, from time to time, to utilise the coffee leaf for a dietetic beverage, but the coffee leaf disease and the injury to the trees have effectually checked this. The subject was much discussed a few years ago in the *Journal*. So on the coffee plantations in Brazil and India, endeavours have been made to distil a spirit from the pulp which surrounds the coffee seed. Coffee grounds are, I believe, extensively collected in France, and revivified and flavoured for usage again; but latterly the agriculturists of France have sought to employ them (M. Payen asserting their great value) for manure. As the consumption of coffee in France is stated to be about 50,000 tons, it is asserted that large quantities of this *marc* might be

obtained from the hospitals, barracks, coffee-houses, &c.

Cocoa is not so largely consumed in this country as on the Continent. But the cocoa shells or husks which are separated from the nibs after sifting, are imported here to the extent often of 500 tons annually, paying a duty of 2s. a cwt., against 9s. 4d. a cwt., charged on cocoa and chocolate. These shells or husks form about 12 per cent. of the weight of the beans. In the manufacture of the finer chocolates this is always separated, and hence accumulates in large quantities in France and Spain. In the cheaper kinds of chocolate and cocoa, these husks are ground with the nibs, and some other cheap farinaceous substance is added. The black appearance of such chocolate is unmistakeable; it will always be found gritty and rough, and, of course, difficult of digestion. The husks are no better than sawdust, and may cause irritation by the minute spiculæ left after grinding.

Mineral Waste.

I must now touch upon the utilisation of mineral waste.

The utilising of tin-plate cuttings, and the recovery of the tin, has become an important and profitable industry. The make of tin-plates in the United Kingdom amounts to about 2,500,000 boxes of one cwt. or more each, of which half are exported. The vast heaps of scrap-tin found about tin-ware works, and the quantities of refuse tin-cans that form such an item of City waste, have long been made the subject of experiment, to separate the tin-coating from the sheet-iron. It is not my object here to go into the mechanical and chemical processes employed in various industries to recover and utilise waste, I simply desire to point out the results which have been attained. In the manufacture of tin-ware, it is said 6 per cent. of the whole of the plates employed, disappears in the form of scrap. Birmingham produces thirty tons per week. Mr. Beck, of that town, is said to have made a profit for many years of £100 a week by taking off the tin from the scrap by solution and precipitation. A very fair trade is done by parties who go about the tin works buying up the tin dust. They even go to France and other countries, and ship it to England to be reduced. This so-called tin dust is really the scum of the tin pot, and, as it is mixed with grease, it is black. It contains a considerable quantity of metal, which is reduced by ignition and flux. An engineering paper states that the waste of tinned iron, used for all kinds of purposes, but especially for saucepans, kettles, button-making, &c., was formerly large, but a method is now employed by which the tin can be recovered from the waste, simply by the action of dilute sulphuric acid. Tin, to the extent of from 5 to 15 per cent, and worth about £97 per ton, with a large amount of sulphate of iron, is thus procured, giving a large profit on the operation. The quantity of boxes required for preserving fish, meat, fruit, vegetables, and other food articles, is enormous. Australia, France, and South America use a great many; the Dominion of Canada and the United States still larger quantities; Nova Scotia and New Brunswick require annually five million pound boxes for preserving lobsters; British Columbia twenty million for salmon; Baltimore consumes forty-five million, which are nearly all for fruit and vegetables; Portland ten million. As tin is an expensive metal, any recovery of it from tin parings and scrap iron is of importance.

Within the last quarter of a century, that formerly neglected mineral—pyrites—has been turned to useful purposes, to supply our manufacturers with the important material—sulphur. Our imports of cupreous iron pyrites (chiefly from Spain and Portugal) now exceeds 540,000 tons annually, and this furnishes, on an average, 130,000 tons of sulphur. The value of the sulphuric acid made in Great Britain is stated to exceed £5,000,000. In the United States, about 50,000 tons of pyrites are also used; in Germany, 74,000 tons; and it is now also utilised in other countries. Instead of throwing away the roasted pyrites, as was formerly the case, when the sulphuric acid maker has extracted the most of the sulphur, he hands over the burnt ore to the copper extractor, who not only separates the copper it contains, but, at the same time, so perfectly removes the sulphur, that the residue, consisting chiefly of peroxide of iron, is suitable for, and is now largely used in various iron-making processes. Besides this, the pyrites in its original condition contains from ½ oz. to 1 oz. of silver per ton; and chemical processes have been devised by which this small quantity can be separated at a profit; for at one of the works on the Tyne more than 16,000 oz. of silver are extracted annually.

In wire-making factories, the dilute sulphuric acid, formerly used to clean the wire, was allowed to run into the sewer, when it had become so charged with the iron scale as to cease

to "bite," and large quantities of refuse wire were employed only to fill up hollows in grading, or thrown into a heap. All this waste material is now, however, converted into articles of commercial value. The processes are simple, and comparatively inexpensive. The diluted acid, charged with iron, is heated in lead-lined tanks, by means of steam pasing through coils of copper pipe, the waste wire being thrown in. In about five days, the acid, under the influence of heat, has taken up a large proportion of iron, and become liquid sulphate of iron, which is then evaporated until it readily deposits the well-known crystals known in commerce as copperas. In one American works, three tons of this solid sulphate are made per day from about twelve tons of the waste acid. The remaining liquid is returned to the receiving tank, to be mixed with more of the waste acid and refuse wire, and so the work goes on in a continuous round. Even the waste of this product from waste is utilised. The settlings of the boiling tank—oxide of iron—together with the waste copperas, an alkali, and an inexpensive substance to give "body," are roasted, ground, and metamorphosed into a pigment quite equal to imported Venetian red. Of this some factories make about 500 barrels per month.

But not only in the inferior metals is waste now prevented, for increased attention is given to the collection of gold formerly lost. Immense heaps of refuse, or "tailings," as they are technically termed, accumulate where mining operations are carried on. The sludge which is emptied from the puddling mills in Australia contains a considerable quantity of fine gold. Much of this is now recovered, and the yield of gold from these exceeds three dwts. per ton. The right to wash these tailings is often sold to the Chinese, who are always well satisfied with the result of their labours.

The quantity of gold used in the arts, in interior and exterior decorations, in photography, electro-gilding, water-gilding, the ornamention of china, &c., is very large, and the greater part is practically lost. Jewellers' sweepings from the floors of the workshops are carefully collected, and even the clothes of the workmen are generally saved, and sent to the refiner. After a large gold coinage at the Royal Mint, there is always a great deficiency in waste and sweep. The sweep is composed of cinders or dust from the forge, the sweepings of the workshops, broken crucibles, the dross which adheres to the ingots of metal after fusion, and of every waste which can possibly contain minute particles of the metal. This is generally sold. The silver and gold from photographers' waste is also now carefully collected, and forms a considerable item of economy. A method of utilising the waste of gold-leaf, used in printing and the arts, is by converting it into what is called fleece gold. The composition is used like the ordinary bronze, except that rather more copal is mixed with it. It is used for all fancy papers for which gold-leaf and bronze have hitherto been used.

Mr. Chance, last session, in a paper read before the Society, gave a record of recent results in the recovery of sulphur from alkali waste.

The waste of the glass furnaces, such as pieces of broken glass, flaw-glass, the hearth droppings, and the glass remaining adherent to the blower's pipe, is utilised again, serving a purpose in the manufacture of glass, similar to rags in paper-making. Agate glass is made by melting waste pieces of coloured glass. 1,000 to 2,000 tons of cullet, or broken glass, is collected in the metropolis alone, and sold to the few city glass works, to be re-melted. Broken bottles are now collected and utilised. Thousands of tons of these are broken every year in London alone. Broken "wines" and broken "sodas" are converted to many useful purposes, the latter expecially. The broken bottles are utilised for the manufacture of cheap jewellery, chimney ornaments, and inferior household glass for the manufacturing districts. They are also used for the manufacture of emery powder, glass paper, &c. Some idea of the number of "sodas" broken in the processes of filling, corking, cleaning, and distributing may be gathered from the circumstance that one great mineral water manufacturer in London sold last year 100 tons. The value of the "metal," as it is styled, is somewhere about 10s. per ton, but it varies according to the demand. When the market for "fancy goods" is active, broken bottles command a better price. A revival of trade sets this particular industry in motion along with others, and broken bottles are enhanced in value. In fact, broken glass and broken pottery serve many purposes, though it is only lately that economic science has learned how to turn them to account.

The Chairman of the Council, in his opening address, stated that the annual value of the bye-products of gas-making, tar, coke, and ammonia, already exceeds, by nearly £3,000,000, that of the coal consumed in our gas works. There are many, like myself, who

can doubtless remember the difficulty the gas works had in former times of getting rid of their tar, and walls and fences were then freely coated with it. The French were the first to make the utilising the waste gases of the coke ovens a commercial success, and now the English and the Germans find that they can gather both the tar and the ammonia water in the gases from coking-coal. It was stated recently in *Engineering*, that at the Gartsherrie Works of the Messrs. Baird, the gases that were wasted in the production of iron have been made to do double duty. Not only have they been utilised, as is common, by being put to the heating of boilers and other kindred work, but, before this is done, they are made to yield the tar, ammonia, &c., which they contain. It is said this is effected without disturbing the smelting process, and without materially lessening the value of the gases for the purpose to which they have been put.

Dr. Siemens's method of heating by means of his regenerative furnace has now been in use many years, and is employed in many thousands of works. It is constructed so as to utilise the waste heat which, in ordinary furnaces, is allowed to escape up the chimney, and to transfer it to the combustion chamber, by which means a considerable saving in fuel is effected.

Mr. Perkin, in his paper before the Society in May, 1879, estimated the value of the coal-tar colours then manufactured in Europe at over £3,000,000 sterling, and this is an industry which only dates from 1856. Although no method for the utilisation of wood-tar is likely to prove of as much practical importance as the discoveries in coal-tar, on account of the limited quantity of wood-tar produced, experiments have, of late years, been conducted with this in view, and several new compounds have been produced; but experiments on a large scale are necessary to determine their practical value.

The utilisation of blast-furnace slag is not new, but has made great progress. The *Times*, two or three years ago (September 16, 1879), gave a long interesting article on the various uses to which it is now applied.

Scattered throughout the iron-making districts of Great Britain are many million tons of scoria or refuse from the blast furnaces, which is technically known as "slag." This slag goes on accumulating at the rate of nearly eight millions of tons per annum, its bulk being some three times that of the iron from which it has been separated. It forms a heavy incumbrance to ironmasters, demanding the purchase of large tracts of land whereupon to deposit it, the investment being, of course, wholly unremunerative. There are one or two exceptions to this rule, where the slag is tipped into the sea, and serves to form land for the works, and where some of the iron works supply slag for the construction of breakwater and training walls. The quantity thus utilised, however, on the Tees, is but about 600,000 tons per annum, forming only a small proportion of the whole yield of the district.

In early times, slag was broken up by hand, and used for road-making, and it so continues to be used, where it can be had without a heavy cost for transport; but there is only a limited demand for this purpose. On the Continent, where stone is scarce, slag plays a prominent part in road-making, as in Silesia and other similarly situated districts. Another direction in which many attempts have been made to utilise slag, both at home and abroad, is to adapt it for constructive purposes, and various schemes have been devised for transforming the highly refractory slag into bricks, sand, and other materials for building.

It is also applied to the manufacture of artificial stone, and moulded into chimney pieces, window-heads, balustrading, and outside ornamental builders' work generally. The stone is composed of two-and-a-half parts of finely pulverised slag, and two-and-a-half parts of ground brick, to one part of Portland cement. The mixture is run into moulds, and sets quickly, the articles being ready for the market in four or five days. Besides bricks and stone articles, the slag is used for making mortar, cement, and concrete. The mortar is a mixture of slag and common lime, the cement being composed of the same materials, with the addition of iron oxides.

Another useful purpose for which it has been successfully utilised is that of glass manufacture. The vitreous character of slag indicates a resemblance to glass in its composition. It does, in fact, contain the principal components of glass, but not in proper proportions, and those in which it is deficient have therefore to be added, with others which are not present. Bottles made of this slag by the Britten Patent Glass Company were shown at the Paris Exhibition in 1878, and received honourable mention.

Another application is to the manufacture of slag-wool. By the action of strong jets of steam, the slag is transformed into a fibrous whitish silicate cotton, which, being metallic, is incombustible, like asbestos. In the con-

struction of new houses with mansard roofs, the space between the interior lath, or panelling, and the exterior covering of zinc, slate, or tin, is filled with this slag-wool, which protects from the rigour of frost in winter, and the intense heat in summer. If in winter the taps, and spouts, and water-pipes are covered with this slag-wool, it prevents the freezing of the water and the bursting of the pipes and joints. This slag-wool is also used now by gardeners to cover plants, and protect them from the effects of sudden changes of temperature.

In the year following my first paper (1855), Dr. Smith, of Philadelphia, read a paper before the Society, on "The Utilisation of the Molten Mineral Products of Smelting Furnaces." This subject is one which has long occupied the attention of the Society, for Mr. T. Twining read a paper on "Pyrolite, or Artificial Lava," in 1848, and a premium of fifty guineas was subsequently offered by the Council, for the application of slag to new and useful purposes, but was not claimed. Mr. Charles Wood, of Middlesbrough, gave exhaustive and instructive papers before the Iron and Steel Institute in 1873 and 1877, showing what had been done in the utilisation of furnace slag, and also read a paper, in 1880, before this Society on the same subject, which has been published in the *Journal*.*

In view of the general usefulness of slag, when converted into the various articles described, it is to be hoped, in the interests of commerce and progress, that the practice of its utilisation may become more and more extended. Doubtless, human progress will show that what is now the veriest waste will, in the course of time, assume a condition of value. Thus will art be made to approximate to nature, in that it will know no waste.

There are one or two other mineral substances, formerly neglected, which have of late years been applied to very extensive important uses. One of these is asbestos. This was long considered a mere curiosity for making small fireproof articles. It is the only flexible fibrous mineral substance that is perfectly indestructible by fire or acids, notwithstanding it consists of fibres as fine as the finest linen. Now it is scarcely possible to enumerate all the uses to which it is applied. Among others are, as a roofing material, cement, paint, fireproof-coating for inside of factories, theatres, &c. in danger of ignition, felting for steampipes, boilers, lining for floors, roofs, &c.

A prominent and peculiar feature in the landscape of the coal-mining regions, is the enormous heaps of black and apparently useless material collected near the outlet of each mine. As the quantity of small waste coal in the United Kingdom has been estimated at 28,000,000 tons per annum, the utilisation of this refuse is a matter of national importance in more senses than one. It is now, in many districts, consolidated into blocks, and besides what is used at home, 412,310 tons of this patent manufactured fuel was exported last year.

In several foreign countries, the pitch from coal-tar is combined with coal-dust, and pressed into the form of bricks, and an excellent fuel is thus produced, which, it is said, will generate a greater amount of heat than can be obtained from the same quantity of any other combustible material employed for utility or comfort, while, at the same time, it can be stored more compactly, and in better shape, than either wood or coal. Some 40,000,000 tons of valueless coal-dust lying in the vicinity of the coal mines and depôts of of Pennsylvania, have been thus gradually utilised. In some American factories, they have found it cheaper and more advantageous to burn only coal-dust or pea-coal. A furnace or grate bar has been specially devised for the purpose of burning this kind of fuel, and there is no doubt, with its increasing uses, but that other convenient devices will be supplied for making it of more practical benefit. The utilisation of this waste in the coal regions of the United States is now a decided success. The American Fuel Company, on the Hudson River, Pennsylvania, works up large quantities of culm (as the coal-dust is technically called) with pitch into blocks, brick-shaped, weighing about 14 lb. each. Anything tending to the utilisation of what is now waste is of value, when we consider that the amount of anthracite coal sent to market represents but about four-fifths of the quantity that is actually raised from the earth, the balance being piled up in unsightly heaps.

Many of the subjects which I have incidentally touched upon, have been so elaborately dealt with by specialists in papers before the members of this Society, that the ground has been taken from under me, and I am but a gatherer and gleaner, summarising, as it were, the results of their descriptions. Although in the period under review, many of

* Vol. xxviii. p. 575.

the waste products of manufactures, formerly thrown away, have been made to serve a useful purpose, there is yet room for fresh efforts in this direction, and the reward is certain. The manufacturer who discovers a heretofore unknown use for the waste product of his work, necessarily cheapens the cost of the principal article of his production, and thus secures an advantage over competitors. Much, as we have seen, has already been done in this way, but there are many other products which could be made under the direction of that mighty converter, chemistry, to yield substances of use and profit.

Science has taught us how to transmute the waste and refuse materials—elements of pollution—into sources of economy and wealth. The utilisation of the sewage of great cities for agricultural ends has virtually been a demonstrated success in Paris and many of our own towns. The same success, by patient experiment, is obtainable in many other waste products, which, in ignorance of their value, we suffer to defile our streets, pollute our rivers, and taint the air we breathe. The purification of the outflow of paper mills, and the utilisation of the sludge and other waste products is now carried out.

It would have been impossible, in the limits of this paper, to refer in detail to more than a few of the principal examples of the successful use of refuse. But those enumerated will serve to show to how great an extent civilisation is daily adding to the useful products of the world, both by economising its resources, and calling forth new ones by the aid of chemistry.

DISCUSSION.

Mr. ROUTLEDGE said the paper trade was probably the one which, of all others, utilised waste products more than any other. They utilised cotton waste, flax waste, hemp waste, jute waste, old ropes, canvass rags, and even, as had been said, stable manure—and he had seen very respectable paper made from that material; they also used spent tan. In fact, the paper manufacturer could use any vegetable fibre whatever, sometimes adding a little animal fibre, to give greater strength. Amongst other materials in connection with the silk industry was mulberry bark; it was customary in all silk-producing countries to grow the mulberry leaves on the young branches of the trees, and when these were stripped, they were cut down, and had hitherto been burned. Some time ago he tried to collect them in Italy, but found it cost too much; there was, however, an immense quantity to be obtained in India, and it would, he believed, produce paper equal to what the Japanese made from the paper mulberry. He had been astounded at the statement in the paper of the enormous quantity of maize wasted in the United States, but could readily believe it, for some years ago, having made an excellent quality printing paper from maize leaves, he took out a patent for it in the States. When he got there, however, he found the cost of collecting the leaves was so great as to render the process practically unworkable. In some places they actually burned the corn to get rid of it. Allusion had been made to the fact that, in 1856, when he introduced esparto, the Society's *Journal* was printed on paper made from it; and he might add that the year before last, a portion of one issue was printed on paper made from bamboo. Asbestos had also been used in paper-making, and would be very valuable in some cases, because an uninflammable paper could be made with it. He had some very fibrous asbestos which could be used admirably for what they called a "filler-up." A considerable deal of attention had been given to the utilisation of the plantain tree and banana for paper-making, but his experiments had shown that it contained so small an amount of fibre, that he did not see how it could pay. The stems of these herbaceous plants contained 80 to 83 per cent. of water, besides a large quantity of mucilaginous and gelatinous matter which must be eliminated, or else fermentation would set up; so that, practically, he did not get much more than 3 to 5 per cent. of fibre. He had made excellent paper from Manilla hemp in the shape of old rope, and, in fact, the whole of the greenbacks introduced by the Americans after the civil war were made from this substance. He had bought hundreds of tons at £2 to £3 a ton, but the present price was £12 to £13. It was collected by the Americans and exported, because they found that by chemical means they could bleach it, and make magnificent paper material. This hemp was produced by slave labour in the Philippine Islands at a very low cost, and sold here as a semi-manufactured fibre, at £25 to £30 a ton for rope-making, and also for making hangings, because it took bright coloured dyes. After being thus used, it came as a waste product to the paper-maker. Jute waste was also used to a large extent; and to-day, although the importation of esparto grass was very large, probably reaching 200,000 tons, without these waste products, consumers would not obtain the cheap paper they did, or the cheap periodicals which were the result of cheap paper. Wood pulp was likely to assume very considerable importance in the paper trade, two or three new processes having recently been introduced, by which pine wood could be converted into cellulose. He had samples of paper made from it, of wonderful strength and tenacity, very much like parchment. This cellulose could be made in two ways, either by boiling the wood with caustic alkali, or by treating it with sulphurous acid; and when the pulp was manufactured

you could hardly tell one from the other. He had recently inspected the process in Sweden, and found the results very extraordinary; but it could hardly be called utilising a waste product, though a large quantity of material was made use of which otherwise would not be of much value.

Mr. ROBOTTOM exhibited a sample of the piassava fibre, which was brought into the London Docks as packing between sugar cases, and also came into Liverpool in the shape of ship's fenders. For some time it was regarded as valueless, but he had introduced it to brush-makers, and it was now largely used for bass brooms. It grew on a tree in Brazil, between Balua and Rio. At present 7,000 tons per annum was used for bass brooms, having practically superseded the old besoms, which were made chiefly by gipsies, both in England and on the Continent. The fibre was produced by a species of palm, about 40 feet high. Another fibre of which he had a specimen was of a white colour, and came from Mexico. At the time of the Russian war, it was feared that Russian hemp would become very dear and scarce, and seeing this fibre in Liverpool, he went over to Mexico to obtain information respecting it. As far as he could learn, it had been known there from the time of Montezuma, but no one would give him any information about it, and he had to make a journey some 400 miles up the country to find where it came from. He there found hundreds of people engaged in collecting it from a species of aloe, not the yucca, which was a taller tree. They pulled down the leaves with a leathern thong attached to a pole, then put them on a board and scraped them, and two men would in this way get about 40 lbs. to 50 lbs. a day. The fibre was then packed in bales and sent on mules to Tampico, a journey of 18 or 20 days, where it was re-packed and sent to England. When first introduced here some people cut it up and sold it for horsehair, but its chief use now was for making small scrubbing-brushes. Another fibre, again, was kittool, which was brought to England from Ceylon, quite by accident. He bought a large quantity at ½d. a pound, with the idea of selling it to market gardeners, to put under strawberries; but, by accident, some of it was used as a kind of brush, for cleaning out an oily saucepan, when it turned a beautiful black, and he then found it could be used as a substitute for bristles. Brush-makers, however, declined to adopt it, because of its great durability; they said the brushes would never wear out. He believed he introduced esparto long before Mr. Routledge, viz., in 1849, with the intention of making it into brooms, but it was not strong enough, and he had to give it up, as he had many other things he had tried to introduce. Lard was the first article he ever made money out of, a butcher whom he knew having a quantity sent him by his son in Chicago, which he could not get rid of. That was in 1827, before the oil was extracted from lard. He sold it to soapmakers as a substitute for palm oil, and they liked it very well. He was much indebted to Mr. Simmonds, who was always ready to afford him information.

Mr. ROUTLEDGE said he only claimed to have introduced esparto for paper-making. The first cargo was brought to Liverpool by Mr. Cowan, but he could make nothing of it; though he was the first man in Scotland to take up his patent process afterwards.

Dr. W. C. OUDAATJE said in the year 1853 or 1854, a notification was sent to Ceylon that horsehair was very scarce, and just at that time he was making investigations into the products of the island, and one of the substances which came under his notice was the kittool fibre; it was then introduced to the notice of the Ceylon Asiatic Society, and a brush which he made of the fibre was sent there also. It was exactly like horsehair, and was used in Ceylon for tying elephants, because of its strength. He could corroborate what had been said as to brush-makers refusing to use it. Since coming to England, he had seen the fibre so beautifully prepared that he could scarcely recognise it; it was so soft and pliant. Mr. Simmonds's contributions to their knowledge of tropical agriculture were so valuable, that his name had become a household word in all parts of the world. With reference to the notice of seaweed, he might say that he had that day submitted a specimen of seaweed which had been brought from Ceylon to the Pharmaceutical Society, in the hope that some use might be found for it, as it seemed to possess great gelatinous properties. There were many products which he should be glad to send to the Society of Arts, where he was sure they would receive that attention and examination for which his countrymen would be very grateful.

Mr. LIGGINS said he had noted down one or two waste products which, he thought, might have escaped the attention of Mr. Simmonds. The first was old wire rope. He ascertained, some 25 years ago, that this old wire rigging, when too rusty to be trusted, was cut into lengths, and used as ballast in ships going to China, where it was used by the Chinese for making the nails with which they fastened up their tea-chests. With regard to waste coal, he had recently noticed in Paris that a large quantity of what used to be called patent fuel was used in the steamers on the Seine; whether the waste coal came from English colliers, which took coal to France, or from French mines, he could not say. The next article he would name was Irish peat; about 30 years ago some friends of his were interested in this question, and though he could not remember all that was anticipated from the peat, he knew candles were made from that material, for he had some of them. If this waste product, which existed in such large

quantities in the South of Ireland, could be utilised in any way, it would be an immense blessing. It was no new thing to make spirit from the molasses of beet-sugar, for rum had been made for generations from molasses, and he had some now which was made in 1851, in Antigua. Again, the manufacture of beetroot sugar itself was not new within 25 years; it was the invention of the great Napoleon, during the long war with this country, when the French could not get sugar from their colonial possessions. That it was so successful now on the Continent, was in consequence of our fiscal regulations letting it in here free of duty; and the profit on the manufacture being paid by a bounty, it was able to drive the West Indian sugar out of the market, so that the whole trade was going to the United States. It was interesting to know that there was a process for recovering the tin from waste tin-plates; and he remembered being much struck, some years ago, when the *Warrior* was being built at Milwall, at seeing the wagon loads of old iron of all kinds going down there. This, he ascertained, was all used to help build the *Warrior*. He was sorry to find that a large quantity of very valuable iron, in the shape of old horse-shoes, was now leaving this country in the shape of ballast, for large ships for China. He grew cotton in the West Indies at the time of the American war, but found it did not pay, and prices offered for the seed on the London market would not pay for sweeping it up. Esparto grass also grew very largely in the West Indies—there were thousands of acres of it—but it did not pay to pick it.

Mr. LIGGINS thought it was rather hard on London gas consumers to have such a high price to pay for gas, if, as stated in the paper, the bye-products paid for the whole cost of the coal.

Chevalier BICKER-CAARTEN said that at the present moment, both in the Netherlands and in Germany, compressed blocks of peat, as well as coal, were used. The mould from under the peat was also used largely for stable purposes. The butterine manufacturers were almost all Dutchmen, and he might say that the greater part of the butter in the shops was butterine. It could be easily detected by melting it in a glass, when the different ingredients would separate into layers. Mr. Simmonds had not alluded to magnesia, which was largely made in France and Germany as a residual product. In France a company had been established to make it from dolomite, and another was being formed in London.

The CHAIRMAN said it had been a great gratification to him to hear this paper, for he had not only known Mr. Simmonds for many years, but had also witnessed his exertions in this very important field. It was needless to speak of the value of these labours, because they had been attested by gentlemen from various parts of the world, but there was a great practical lesson to be learned from it. Many years ago, in connection with other important pursuits in which he was engaged in the promotion of industrial economics, Mr. Simmonds took up this subject; and if others would follow his example, great benefit would result. People were often deceived about the progress of science in any particular branch. They saw men of the greatest distinction applying themselves to it, and fancied that the whole field was occupied. A few years ago, all the observatories of Europe were occupied in the same direction; and when any new discovery was made it was generally made rather by private outside observatories than by public establishments. There was thus a great waste of energy; but that had been remedied of late years, each observatory taking upon itself some particular duty, and thus the whole world benefited. If, therefore, any one would, in the very humblest way, do as Mr. Simmonds had done—take up one subject and apply himself to it—he would do more good to the world than by simply following in the wake of some great man, reading his books, and doing nothing but accept his ideas. In fact, the great lesson to be learned from this paper was to utilise the mind itself, and not allow mental energy to become a waste product. It was sometimes surprising, if you wanted information in some particular branch of science, to find there was scarcely anyone who knew anything about it, and that, in fact, all the knowledge about it was half a century old. This subject of waste products had very largely occupied the attention of the Society at various periods, and Mr. Oudaatje had referred to one department in which it had been able to render very useful service. It had been for a century the practice of men, in different parts of the world, who had not the appliances which were available here, to send their products to the Society of Arts for investigation, and, sometimes, by their mere exhibition in that room, they had developed into large branches of industry. The subject was a very wide one, because there was waste in every direction, and what was waste at one moment became utility at another. The waste of resources in this country, instead of being a subject of pride, was really most melancholy. The waste even of natural elements—the waste of power, such as was described by Dr. Siemens—the waste of products was all very great. In fact, there was hardly a branch of the whole subject of industrial economies which did not require the closest attention, not only from individuals and from societies such as that, but from the government which represented the community. It was really a cruel thing that men like Mr. Routledge and Mr. Robottom should have to apply their time and money in ascertaining the value of hundreds of substances which were brought into the market; there was no reason why they should not have the assistance of the community, in labours which were for the general benefit. He had taken a deep interest in this subject for a long

time; he believed he was the means of developing the reduction of palm oil, which had largely increased the amount of that commodity brought to this country; and it was in the power of anyone, if he applied himself to some one particular subject, to do an immense deal of good, whilst by following always in the wake of others a man's work was unprofitable, both to himself and to the community. He concluded by proposing a vote of thanks to Mr. Simmonds.

Mr. Simmonds, in reply, thanked the meeting for the attention given to his paper. He said he had not had time to allude to many matters he should have liked to touch upon; but with regard to fibrous plants, he might say that when in the Mauritius he found the aloe was largely utilised. It was shown in the Paris Exhibition of 1878, and attracted much attention from its beauty and length of fibre. He believed it could be obtained in many of our colonies, as well as in the West Indian Islands and in Mexico. The great difficulty with all these products was the cost of labour and freight.

Correction.—Mr. C. B. Phillips writes in reference to his remarks on Mr. Gibbs' paper (see *Journal* for December 8, p. 73), that he did not wish to convey the idea that he had been beaten in the competitive trials of machines for drying crops at Reading, but that he was unsuccessful in obtaining the prize. Mr. Phillips adds that the judges spoke favourably of his machine.

Miscellaneous.

*REPORT OF SCREW GAUGE COMMITTEE OF THE BRITISH ASSOCIATION.**

1. This committee was formed by the General Committee of the British Association assembled at York in August and September, 1881, for the purpose of determining a gauge for the manufacture of the various small screws in telegraphic and electrical apparatus, in clockwork, and for other analogous purposes.

2. At that meeting a paper was read by Mr. Preece, pointing out the desirability of establishing such a gauge. Although the Whitworth gauge is almost invariably adopted for the bolts and screws used in millwork and engineering in England, no general system has been hitherto applied to the smaller screws, used either in clockwork, philosophical instrument work, or in the numerous practical applications of electricity that are now rapidly becoming so important. In fact, at the present time, gauges and screw-plates almost equal in number the makers engaged in the trade. One instance was brought to the attention of the committee, by a manufacturer who had to execute an order for railway signal apparatus, in accordance with three sample instruments, containing among them twenty-one screws of different threads, not one of which happened to be in use in his shop. There is now no recognised form of thread, no specified number of threads per inch—in fact, no generally accepted gauge, based on practice and experience. Great inconvenience is felt in providing for repairs, which are, in consequence, more costly and less efficient.

The employment of some coherent and uniform system is manifestly required. It not only would render repairs easier, speedier, and cheaper, but it would introduce interchangeability of parts, and further the extension of piece-work; and it would reduce the equipment of workshops with special and costly tools.

3. The subject of uniformity in screws has been very warmly taken up by the Société des Arts de Genève, which appointed a committee in December, 1876, who, after assiduous labours, issued a report in 1878. The system proposed by them has been fully described by Professor Thury in two pamphlets published in Geneva.* The committee collected numerous screws of all sizes from many factories, measured them carefully, tabulated their several dimensions, and plotted the results by the ordinary method of linear co-ordinates. They determined the mathematical equations to curves that most closely corresponded with the ratios of diameter to pitch thus found to have been employed in practice, and adopted the one which most nearly represented the mean average proportions of the screws in use at various shops, and in different countries.

The Swiss committee took 1 millimetre pitch as the basis of their system. It was agreed that such a pitch was best adapted to a screw having a diameter of 6 millimetres. The form of thread adopted was triangular, the angle made by producing the two sides being approximately $47\frac{1}{2}°$; the depth being $\frac{3}{5}$ of the pitch, the top being rounded off by a radius $\frac{1}{6}$, and the bottom by a radius $\frac{1}{5}$ of the pitch.

The committee has had an opportunity of examining screw-plates, and numerous packets of the corresponding screws manufactured on this system.

The following table gives the pitches and diameters,

* Report of the Committee, consisting of Sir Joseph Whitworth, Dr. Siemens, Sir F. J. Bramwell, Mr. A. Stroh, Mr. Beck, Mr. W. H. Preece, Mr. E. Crompton, Mr. E. Rigg, Mr. A. Le Neve Foster, Mr. Latimer Clark, Mr. Buckney, and Mr. H. Trueman Wood (Secretary), appointed for the purpose of determining a gauge for the manufacture of the various small screws used in Telegraphic and Electrical Apparatus, in Clockwork, and for other analogous purposes.

* *Systématique des vis Horlogères*, Genève, 1878. *Notice sur le Système des vis de la Filière Suisse*, Genève, 1880.

in millimetres and "mils,"* to two significant figures, and the number of threads per inch of all the screws comprised in the small screw series, which happens to cover the exact ground to which the attention of the committee has been specially directed, namely, diameters below the $\frac{1}{4}$-inch.

TABLE OF SWISS SCREWS.

No.	Pitch.		Diameter.		Threads per inch.
	Mm.	Mil.	Mm.	Mil.	
25	0·072	2·8	0·25	10	357
24	0·080	3·1	0·29	11	323
23	0·089	3·5	0·33	13	286
22	0·098	3·9	0·37	15	250
21	0·11	4·3	0·42	17	233
20	0·12	4·8	0·48	19	208
19	0·14	5·3	0·54	21	189
18	0·15	5·9	0·62	24	170
17	0·17	6·6	0·70	28	152
16	0·19	7·3	0·79	31	137
15	0·21	8·1	0·90	35	124
14	0·23	9·0	1·00	40	111
13	0·25	10·0	1·2	46	100
12	0·28	11·	1·3	52	91
11	0·31	12·	1·5	59	83
10	0·35	14·	1·7	67	71·4
9	0·39	15·	1·9	76	66·7
8	0·43	17·	2·2	86	58·8
7	0·48	19·	2·5	97	52·6
6	0·53	21·	2·8	111	47·6
5	0·59	23·	3·2	126	43·5
4	0·66	26·	3·6	142	38·5
3	0·73	29·	4·1	162	34·5
2	0·81	32·	4·7	183	31·2
1	0·90	35·	5·4	208	28·6
0	1·00	39·	6·0	236	25·6

It is to be observed that the numbers by which the screws are designated, given in the first column, are not arbitrary. Each pitch of the series is $\frac{9}{10}$ths of that which succeeds it in the table.

Thus the several pitches are:—

$$1 \text{ m.}; \ \frac{9}{10}\text{mm.}; \left(\frac{9}{10}\right)^2 \text{mm.}; \left(\frac{9}{10}\right)^3 \text{mm.}; \ldots \left(\frac{9}{10}\right)^n \text{mm.}$$

This series may be expressed in the form:—

$$0{\cdot}9^0; \ 0{\cdot}9^1; \ 0{\cdot}9^2; \ 0{\cdot}9^3; \ \ldots \ 0{\cdot}9^n; \ \ldots \quad (1)$$

whence it is at once evident that the designating number of the screw is the index of the power to which 0·9 must be raised in order to ascertain its exact pitch in millimetres.

* The "mil" is the thousandth part of the British inch.

The method by which the relation between pitch and diameter is arrived at will be gathered from the following explanation:—

Let D represent the diameter and P the pitch. Then, generally,

$$D = f(P)$$

Evidently there can be no constant term, for when D = 0, P must also = 0. Moreover, D practically cannot be a simple multiple of P, for experience has shown that small screws must have a less number of threads per diameter than large screws.

Hence the formula will be of the form

$$D = m P^k \quad . \ . \ . \quad (2)$$

where m and k are constants to be determined.

Since 1^k is 1 whatever be the value of k, it follows that the co-efficient m represents the value of D when P is 1. The Swiss committee agreed that the unit pitch (1 millimetre) should be adopted for the screw having a diameter of 6 millimetres; in other words they make $m = 6$.

The value of k must be ascertained by trial.

$k = 1$ would give a constant ratio, which we know is inadmissible.

$k = 2$ will be found on trial to give a far too rapid decrease in the ratio of diameter to pitch.

The several simple fractions between these limiting values were tried in succession, and the results obtained when using $\frac{6}{5}$ were found to give results that best accord with practice and experience.

Substituting the values thus arrived at in (2), the formula becomes

$$D = 6P^{\frac{6}{5}} \quad . \ . \ . \quad (3)$$

The Swiss system is thus very complete, but there are reasons which prevent this committee from recommending its adoption in its entirety.

4. No one has done more to establish gauges of all kinds in England than Sir Joseph Whitworth. His classical paper on "A Uniform System of Screw Threads," was communicated, as far back as 1841, to the Institution of Civil Engineers. He had made an extensive collection of screw-bolts from the principal workshops throughout England, and the average thread was carefully measured for different diameters. The $\frac{1}{4}$, $\frac{1}{2}$, 1, and $1\frac{1}{2}$ inches were selected and taken as the fixed points of a scale by which the intermediate sizes were regulated. The result is an admirable thread for the large iron bolts and screws used in fitting up steam-engines and other machinery. The angle made by the sides of this thread is 55°. One-sixth of the depth of the thread is rounded off from the top, and one-sixth from the bottom. The actual depth is rather more than three-fifths, and less than two-thirds of the pitch.

The slow adoption of such an admirable system was perhaps due, in great measure, to the fact that it was put forward by an individual, and not by an association. A single individual, however exalted his reputation, cannot secure that immediate and

universal attention which is obtained by such an organisation as the British Association. The system of units of electrical measurements sanctioned by the association obtained instant recognition, and has now, thanks to the Congress of Electricians, held in Paris in October, 1881, become universally accepted. It is hoped that the same result will follow the recommendations of this committee.

5. The question of the introduction of the metrical system occupied the serious consideration of the committee, but, considering the fact that it is not generally adopted in engineering or manufacture in England, and that it is as yet little understood by our workmen, it was thought better to suggest no change in this direction. The committee is not insensible to the simplicity of the metrical system and to its possible universality, nor to the fact of its gradual introduction in scientific circles, but while the manufacturing interests are still wedded to the British inch, and its multiples and its sub-multiples, and while the British legal standard of length is still the yard, the committee has felt it impossible to suggest a change which has little chance of adoption, and which may jeopardise the introduction of that with which they are more concerned—viz., a uniform screw-thread.

Hence it was determined that the unit of length taken should be the "mil," and that the decimal system should be adopted for expressing dimensions.

6. The use of a screw is to draw together and to unite certain parts of apparatus in firm and intimate contact. To attain these ends, a screw must facilitate the application of mechanical power to draw the parts together, and it must possess strength to hold them so; it must not interfere with the easy separation of these united parts when necessary; it must possess durability—that is, it must be capable of repeated use without undue friction and without wear, otherwise it will speedily become loose, and dangerous when frequently removed and restored. There has to be considered the pitch of the screw, its relation to the diameter of the bolt on which it is cut, the depth of the cut, and the form of the thread. The pitch primarily determines the power of the screw, for it determines, for each diameter, the angle of the inclined plane; the depth determines the section of core left to resist shear or rupture; while the form of the thread determines the durability and efficiency, and determines also the surface of thread to bear endway strain.

7. The committee have devoted very considerable attention to the pitch, form, and depth of screws, and they have compared together a large number of different kinds, some of which are in actual use, while others have only been suggested. They have, moreover, decided on recommending the adoption of the Whitworth form of thread, not only because it is so well known, but because experience has proved it excellent and unsurpassed when employed for engineers' bolts. The committee, however, are not unanimous on all questions involved by this proposal, and as there are several points that require to be thoroughly sifted and tested, they ask to be reconstituted, and to be allowed a small grant to put their proposal to the test of practice, and to have a few gauges constructed for distribution or examination.

THE COMMERCIAL MUSEUM OF BRUSSELS.

Consul Wilson, in his last report, states that the Belgium Government have just opened, in Brussels, a commercial museum, under the control of the Minister of Foreign Affairs. The declared intention of the Government, in creating this museum, is the exhibition of specimens of both raw materials and manufactures of all countries. In arranging the samples, a portion of the building is devoted to each category of products from all countries, and these are so classified that a visitor can at once see, not only the origin of each specimen, but, with the aid of a catalogue gratuitously furnished, may also study its industrial value or adaptability to the markets he desires to reach. In addition to the information supplied in the catalogue, there is a *bureau d'information* for the purpose of answering all inquiries, and explaining such additional facts as the Government may possess, relating to the origin, character, and practical purposes of each sample, with the cost of its production, and all other items relating to its commercial value. Another of the functions of this bureau is to procure, for the information of all concerned, plans and specifications of all proposed improvements either foreign or domestic, that may be yet open to a competition for contract, with a list of the awards of such contracts as have already been made, including the terms and conditions of the same. Desks, tables, and writing materials are also provided for the convenience of visitors who may wish to avail themselves of them in taking note of any of the contents of the sample department. There is also attached to the museum a library, composed of technical works on the principal industries of the world, dictionaries of technology, catalogues of museums of art and manufacture, foreign journals of manufacture and commerce, and especially such as contain notices of proposed contracts for all kinds of material and labour products. Another department, called the *indicateur*, contains the special archives of the museum. No outside correspondence is permitted directly with this bureau, and all communications intended for it must be first inscribed at the Ministry of Foreign Affairs, after which they are sent to the mnseum by the chief clerk of the Department of Commerce and Consulates. Documents issuing from this bureau must be signed and submitted for the approbation of the chief

secretary of the Department of State, and then forwarded to the Minister of Foreign Affairs for his approval. All documents furnishing information as to the articles on exhibition in the museum are regularly filed and numbered with a special number, so that, by consulting the catalogue and the number of the document, any article may at once be found. A weekly journal is published in connection with the museum, devoted to practical information on all branches of industry and commerce, generally gleaned from foreign sources by the consuls and other foreign agents of the Government. The public is admitted without fee every day except Sunday, from half-past nine in the morning till four in the afternoon, and any person wishing for special information, not obtainable from the samples, by signifying to the doorkeeper his desire to consult the *bureau d'information*, is at once admitted, and the information readily supplied. It is intended so to extend the sample department as to embrace not only specimens of foreign manufactures, but every kind of foreign crude or raw material capable of being converted into manufactured products by the industrial establishments of Belgium. There is also in this building a very important department, called the "package and finishing room." Under the impression that the manner in which merchandise is packed, labelled, and otherwise prepared for the market has much to do with its recommendation, the Government have devoted these rooms to the study of this art in all its details. It is intended here to exhibit the finest specimens of packing, and the most attractively prepared merchandise, both foreign and domestic. In announcing the object of the museum, the Government claim that, as a producing country, Belgium has nothing to fear from the competition of any foreign country, either as to the quality of her manufactures, or the price of her soil products, but declares that, in order to secure her legitimate degree of commercial success in distant foreign countries, two things are absolutely necessary. The first is to free herself of her dependence upon the other great commercial States that surround her, and sell her merchandise in foreign markets as their own, thus depriving her manufacturers of the profits of direct sales to the consumers; and the second is better to conform the manufacture of her merchandise to the taste and wants of foreign markets. It has given orders to all its consuls and other foreign agents to collect from every part of the world where they may be located, samples of such manufactures as are most in use there, to ascertain the styles and patterns most esteemed, and to send them home to this museum. These officers are especially enjoined to send home specimens of metallic ores, textile fabrics, and all such raw material as may in any way be capable of being converted into useful products, that the genius of the Belgian manufacturers may be stimulated to a more diversified production.

General Notes.

PARCELS POST IN BELGIUM. — The Belgium Minister of Public Works has decided that international postal parcels of five kilogrammes (11 lb.) weight and under, shall in future be exempt from the additional charge of 25 centimes (2½d.), for customs' formalities and porterage, hitherto payable on delivery, if they bear the words "*bureau restant*," "*en gare*," or "*sur entrepôt*." and be cleared and called for by the persons to whom they are addressed.

INTERNATIONAL RAILWAY SAFETY EXHIBITION.—A provisional committee, with Mr. Charles Boysset, vice-president of the French Chamber, as president, has been formed for organising an international exhibition of appliances, calculated to ensure the safety of railway passengers, to be held in the Palais de l'Industrie, Paris, in 1883. The three classes of objects to be admitted are:—Systems of coupling, arrangements of signals, and various brakes.

PHOTOGRAPHIC REPRODUCTION. — At a recent meeting of the *Académie des Sciences*, M. Marey made a communication as to the new process of M. Charles Petit, called *similigravure*, for reproducing photographs on metal, so as to print from them in the same way as from, and concurrently with, ordinary typographical characters. Two specimens of the proofs obtained, one representing the attitudes of a man walking at the parade step, and the other a white horse leaping, were considered as highly satisfactory, and as showing that an additional step has been made in the practical application of photography to scientific demonstrations; but, at the same time, it was believed that the process is capable of further improvement.

APPLIANCE FOR SOOT PREVENTION. — A Berlin engineer, Herr Albert Petzold, has devised an appliance for preventing the escape of soot into the atmosphere. It consists of two hollow cylinders, made of sheet iron, arranged one underneath the other, but with space between them rather greater than the diameter. They are placed, either in the chimney, or in a chamber above the fire-grate, and in communication with the chimney. The upper cylinder rests on a plate closing the chamber, except inside the cylinder, so that the air around this latter is in repose. A band of sheet brass is wound spirally inside the two cylinders, thus giving the smoke a rotatory motion, and causing the particles of soot and ash to pass out at the space between the two cylinders, owing to the centrifugal force, and fall down in the chamber outside the lower cylinder, to be removed at intervals by a door.

Journal of the Society of Arts.

No. 1,571. Vol. XXX.

FRIDAY, DECEMBER 29, 1882.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

All the tickets having now been disposed of, the issue has ceased. As all the available accommodation will be required for those members who have received tickets, it will be understood that no member can be admitted without a ticket.

The Secretary will feel greatly obliged if any member who is unable to use his ticket, will kindly send it back.

Proceedings of the Society.

CANTOR LECTURES.

DYNAMO-ELECTRIC MACHINERY.

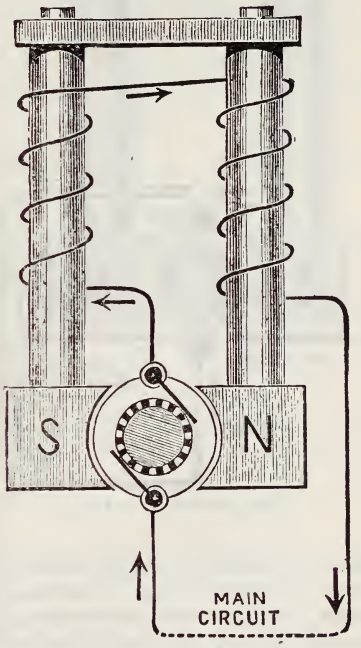
By Professor Silvanus P. Thompson, B.A., D.Sc., M.S.T.E.

Lecture I.—The Dynamo in Theory.

By "Dynamo-electric Machinery," in the most general etymological sense of the term, is meant machinery for converting the energy of mechanical motion into the energy of electric currents, or *vice versa*. From this wide definition must be excepted machines like the well-known statical induction-machine of Holtz, whose action is purely electrostatic. Those machines only are included in the definition whose action is dependent on the principle of electro-magnetic induction, discovered by Faraday, in 1831. It is, however, not quite easy to decide what machines shall be called dynamo-electric machines, because the sense in which the term is used commonly is narrow, and restricted in a manner not quite logical.

The name dynamo-electric machine appears to have been first employed by Dr. Werner Siemens, in his communication of January 17th 1867, to the Berlin Academy, in which he described a machine for generating electric currents by the application of mechanical power, the currents being induced in the coils of a rotating armature by the action of electro-magnets, which were themselves excited by the currents so generated. The machine was, in fact, a self-exciting dynamo, with the field magnets and armature united "in series" to the external circuit, or what we now call a "series-dynamo," a diagramatic representation of which is given in Fig. 1. But the

Fig. 1.



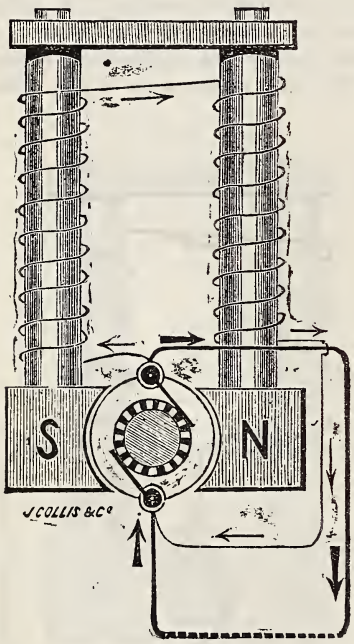
The Series Dynamo.

term dynamo-electric machine, then introduced into electric technology, has not remained thus restrained to its narrowest meaning. It was next applied to machines of kindred nature, in which, though self-excited, only a portion of the entire current generated by the rotating armature was applied to excite the field-magnets (see Fig. 2). This principle of working (now known as that of the "shunt-dynamo"), first introduced by Wheatstone, is but a variation of the former

arrangement in detail, and no violence is done to the original term to apply it to both cases. In fact, the name was welcomed as being convenient in practice for distinguishing such machines from those which were not self-excited—those in which either steel magnets or separately-excited electro-magnets were used to produce the magnetic field.

But since the great development of electric lighting took place, it has been found convenient to use generating machines in certain combinations, in which the self-exciting principle is abandoned. Some systems of electric lights require alternating currents,

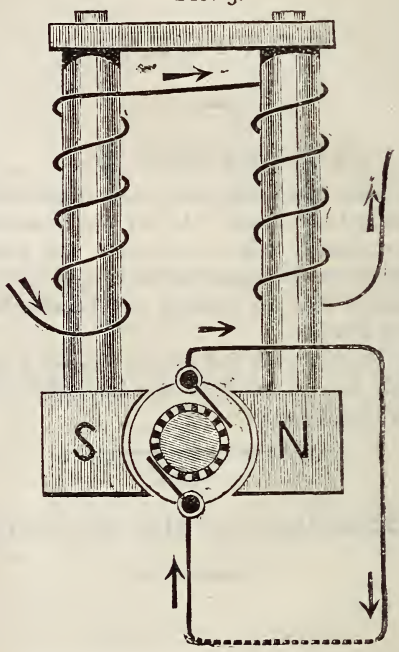
FIG. 2.



THE SHUNT DYNAMO.

produced in machines which cannot excite their own magnets with a continuous magnetisation; and there are other systems where continuous currents are employed, in which also practice has shown that the currents are better regulated when the magnets of the dynamos are separately excited by currents derived from an external source. There is, then, a third class of dynamo-electric machine, the "separately-excited dynamo" (Fig. 3), which was indeed earlier than either of the preceding, having been brought out by Wilde in 1866. A dynamo is a dynamo in fact, whether its magnets be excited by the whole of its own current, or by a part of its own current, or by a current from an independent source. The source of the magnetising power is indifferent, provided a magnetic "field" of sufficient intensity be produced wherein the generating coils can be rotated. Now, as it does no matter where the magnetising power comes from, it is clear that we must include amongst possible sources the power of permanent steel magnets. In short, the arbitrary distinction between so-called magneto-electric machines (see Fig. 4, p. 121) and dynamo-electric machines fails when examined carefully. In all these machines a magnet, whether permanently excited, independently excited, or self-excited, is employed to provide a field of magnetic force

FIG. 3.



THE SEPARATELY-EXCITED DYNAMO.

And in all of them dynamical power is employed to do the work of rotating the coils of the armature, in order to generate the electric currents.

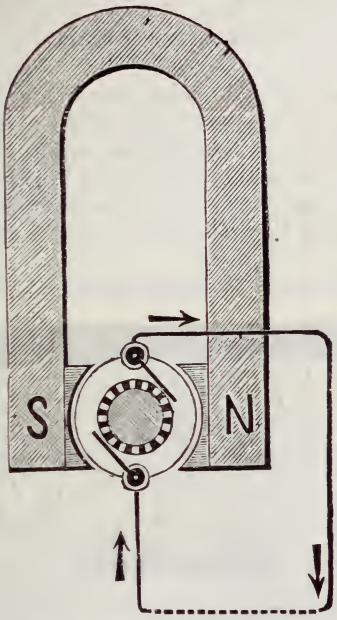
The true and comprehensive definition of a dynamo electric machine is, then, the following:—A dynamo-electric machine is a machine for converting energy in the form of dynamical power into energy in the form of electric currents, by the operation of setting conductors (usually in the form of coils of copper wire) to rotate in a magnetic field.

Inasmuch, however, as every dynamo-electric machine, in the most general sense of the term as now laid down, will work as a motor, and becomes a source of mechanical power when

supplied with electric currents, it is possible to discuss dynamo-electric machinery from the opposite points of view in serving the two converse functions, in short, to treat the dynamo on the one hand as a generator, on the other hand as a motor.

It is as a generator only that the action of the dynamo will be considered in the first two of these lectures, reserving considerations respecting its functions as a motor for the third lecture of the present course.

FIG. 4.



THE MAGNETO DYNAMO.

THE DYNAMO IN THEORY.

To treat exhaustively the theory of dynamo-electric machines, would require not one lecture, but many. It would be necessary, moreover, to enter upon lengthy mathematical and geometrical discussions, which would be out of place in the present course, which is expected to deal with subjects from an industrial, rather than from a purely scientific aspect. The mathematical theory of the dynamo is, indeed, very complex, and takes different forms for its expression in the four classes of machine now included under the one name of "dynamo." For every different variety in each of these classes, there is a fresh variety of mathematical symbols. The theory of alternate current machines is entirely different from that of machines which are to furnish continuous and constant currents. Every form of armature and coils requires its own specific treatment in symbols; and the simple consideration of putting iron cores into the coils, when treated mathematically, introduces such complex expressions as to yield no hopes of a satisfactory general solution.

The theory of the dynamo, then, which will be developed in the present lecture, will not be a general mathematical theory. The aim will be to deal with physical and experimental rather than mathematical ideas. A physical theory of the dynamo is not new, though none of any great completeness has yet been given,* most of such explanations being devoted to single machines of some particular type.

It will here be my aim to develop a general physical theory, applicable to all the varied types of dynamo-electric machines, and to trace it out into a number of corollaries, bearing upon the construction of such machines. Having recited these consequences, which we shall deduce from theory, it will then remain to see how these consequences are verified and embodied in the various forms assumed by the dynamo in practice.

PHYSICAL THEORY OF DYNAMO-ELECTRIC MACHINES.

All dynamos are based upon the discovery made by Faraday in 1831, that electric currents are generated in conductors by moving them in a magnetic field. Faraday's principle may be enunciated as follows:—When a conductor is moved in a field of magnetic force in any way so as to cut the lines of force, there is an electromotive force produced in the conductor, in a direction at right-angles to the direction of the motion,† and at right-angles also to the direction of the lines of force, and to the right

* See Du Moncel ("Exposé des Applications de l'Electricité," vol. ii.); Niaudet, "Machines Electriques;" Schellen, "Die Magnet-und Dynamo-elektrischen Maschinen;" Antoine Breguet (see "Annales de Chimie et de Physique," 1879). See also some theoretical papers by Clerk Maxwell in "Philosophical Magazine," 1867, and by MM. Marcel Deprez, Cabanellas, de Goarant, and others in the "Comptes Rendus;" also sundry papers by Frölich, Werner Siemens, Hagenbach, and others in the "Elektrotechnische Zeitschrift" and other German publications. Of more general scope is the physical theory advanced by the late M. Antoine Breguet, which deals with dynamos of the Gramme and Siemens type, and of which a detailed summary is given in "Electric Illumination." In an introductory chapter of the same work I have endeavoured to lay the foundation of a more general physical theory. An admirable series of papers on the mathematical theory of dynamo-electric machines, from the pen of a well-known professor of physics, is at present appearing in the columns of *The Electrician*.

† Or, more strictly to the resolved part of the motion in a plane perpendicular to the lines of force.

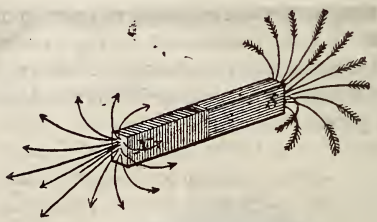
of the lines of force, as viewed from the point from which the motion originates.*

This induced electromotive force is, as Faraday showed, proportional to the number of lines of magnetic force cut per second; and is, therefore, proportional to the intensity of the magnetic "field," and to the length and velocity of the moving conductor. For steady currents, the flow of electricity in the conductor is, by Ohm's well-known law, directly proportional to this electromotive force, and inversely proportional to the resistance of the conductor. For sudden currents, or currents whose strength is varying rapidly, this is no longer true. And it is one of the most important matters, though one too often overlooked in the construction of dynamo-electric machinery, that the "resistance" of a coil of wire, or of a circuit, is by no means the only obstacle offered to the generation of a momentary current in that coil or circuit; but that, on the contrary, the self-induction exercised by one part of a coil or circuit upon another part or parts of the same, is, in many cases, quite as important a consideration, and in some cases a more important consideration, than the resistance.

To understand clearly Faraday's principle—that is to say, how it is that the act of moving a wire so as to cut magnetic lines of force can generate a current of electricity in that wire—let us inquire what a current of electricity is.

A wire through which a current of electricity is flowing looks no different from any other wire. No man has ever yet seen the electricity running along in a wire, or knows precisely what is happening there. Indeed, it is still a disputed point which way the electricity flows, or whether or not there are two currents flowing simultaneously in opposite directions. Until we know absolutely certainly what electricity is, we cannot expect to know precisely what a current of electricity is. But no electrician is in any doubt as to one most vital matter, namely, that when an electric current flows through a wire, the magnetic forces with which that wire is thereby, for the time, endowed, reside not in the wire at all, but in the space surrounding it. Every one knows that the space or "field" surrounding a magnet is full of magnetic "lines of force," and that these lines run in tufts (Fig. 5*) from the N-pointing pole to the S-pointing pole of the magnet, invisible until revealed by dusting iron filings into the field, whereby their presence is made known, though

FIG. 5.*

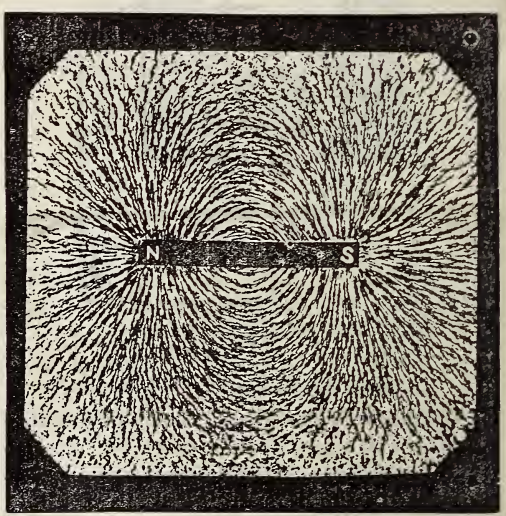


LINES OF FORCE OF BAR-MAGNET.

they are always in reality there (Fig. 6). A view of the magnetic field at the pole of a bar-magnet, as seen end-on, would of course exhibit merely radial lines, as in Fig. 7.

Now, every electric current (so-called) is surrounded by a magnetic field, the lines of

FIG. 6.



MAGNETIC FIELD OF BAR-MAGNET.

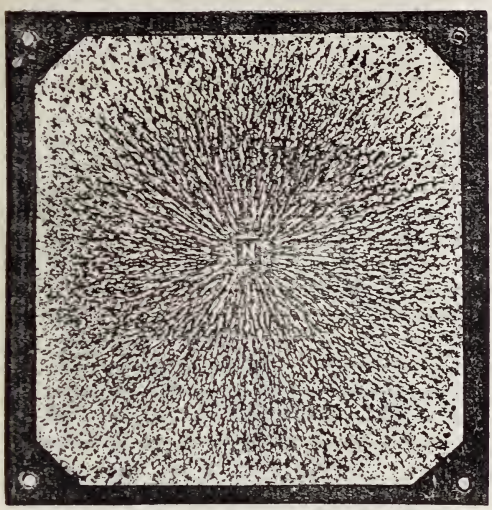
which can be similarly revealed. To observe them, a hole is bored through a card or a piece of glass, and the wire which carries the current must be passed up through the hole. When iron filings are dusted into the field they assume the form of concentric circles (Fig. 8), showing that the lines of force run

* A more usual rule for remembering the direction of the induced currents is the following adaptation from Ampère's well-known rule:—Supposing a figure swimming in any conductor to turn so as to look along the (positive direction of the) lines of force. Then, if he and the conductor be moved towards his right hand, he will be swimming with the current induced by this motion.

* For the use of Figs. 5, 6, 7, 8, & 9, I am indebted to the kind courtesy of the Editors and Publishers of *Engineering*, who permit me to reproduce them from the volume, "Electric Illumination," recently issued under the editorship of Mr. James Dredge, C.E.

completely round the wire, and do not stand out in tufts. In fact, every conducting wire is surrounded by a sort of magnetic whirl, like that shown in Fig. 9. A great part of the

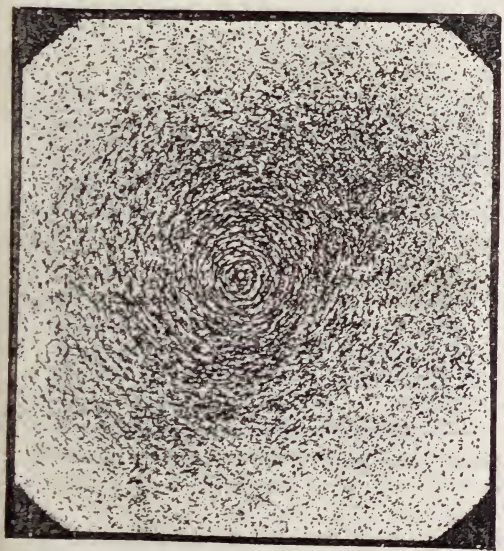
FIG. 7.



MAGNETIC FIELD ROUND ONE POLE, END-ON.

energy of the so-called electric current in the wire consists in these external magnetic whirls. To set them up requires an expenditure of

FIG. 8.



MAGNETIC FIELD SURROUNDING CURRENT. THE CONDUCTING WIRE SEEN END-ON.

energy; and to maintain them requires also a constant expenditure of energy. It is these magnetic whirls which act on magnets, and cause them to set as galvanometer needles do, at right angles to the conducting wire.

Now, Faraday's principle is nothing more nor less than this:—That by moving a wire near a magnet, across a space in which there are magnetic lines, the motion of the wire, as it cuts across those magnetic lines, sets up magnetic whirls round the moving wire, or, in other language, generates a so-called current of electricity in that wire. Poking a magnet-pole into a loop or circuit of wire also necessarily generates a momentary current in the wire loop, because it momentarily sets up magnetic whirls. In Faraday's language, this action increases the number of magnetic lines of force intercepted by the circuit.

FIG. 9.



MAGNETIC WHIRL SURROUNDING WIRE CARRYING CURRENT.

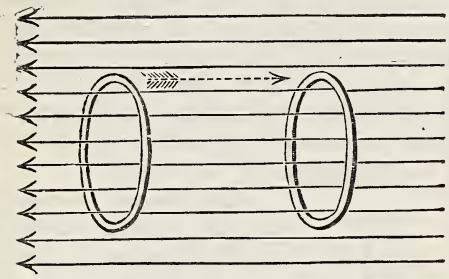
It is, however, necessary that the moving conductor should, in its motion, so cut the lines of force as to alter the number of lines of force that pass through the circuit of which the moving conductor forms part. If a conducting circuit—a wire ring or single coil, for example—be moved along in a uniform magnetic field, as indicated in Fig. 10 (p. 124), so that only the same lines of force pass through it, no current will be generated. Or, if again, as in Fig. 11 (p. 124), the coil be moved, by a motion of translation, to another part of the uniform field, as many lines of force will be left behind as are gained in advancing from its first to its second position, and there will be no current generated in the coil. If the coil be merely rotated on itself round a central axis, like the rim of a fly-wheel, it will not cut any more lines of force than before, and this motion will generate no current. But if, as in Fig. 12 (p. 124), the coil be tilted in its motion across the uniform field, or rotated round any axis in its own plane, then the number of lines of force that traverse it will be altered, and currents will be generated. These currents will flow round the ring-coil in the positive* sense (as viewed from the point toward which

* The positive sense of motion round a circle is that opposite to the sense in which the hands of a clock go round.

the lines of force run), if the effect of the movement is to diminish the number of lines of force that cross the coil; they will flow round in the opposite sense, if the effect of the movement is to increase the number of intercepted lines of force.

If the field of force be not a uniform one, then the effect of taking the coil, by a simple motion

FIG. 10.

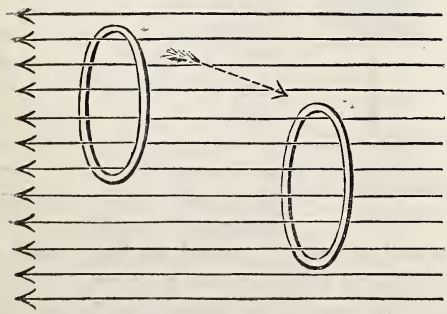


CIRCUIT MOVED WITHOUT CUTTING LINES OF FORCE OF UNIFORM MAGNETIC FIELD.

of translation, from a place where the lines of force are dense to a place where they are less dense, as from position 1 to position 2 in Fig. 13, will be to generate currents. Or, if the motion be to a place where the lines of force run in the reverse direction, the effect will be the same, but even more powerful.

We may now summarise the points under consideration, and some of their immediate consequences, in the following manner:—

FIG. 11.



CIRCUIT MOVED WITHOUT CUTTING ANY MORE LINES OF FORCE.

(1.) A part, at least, of the energy of an electric current exists in the form of magnetic whirls in the space surrounding the conductor.

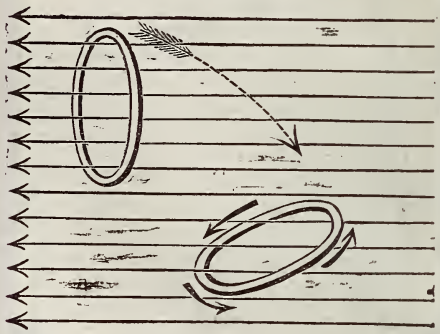
(2.) Currents can be generated in conductors by setting up magnetic whirls round them.

(3.) We can set up magnetic whirls in conductors by moving magnets near them, or moving them near magnets.

(4.) To set up and maintain such magnetic whirls uses up a continuous expenditure of energy, or, in other words, consumes power.

(5.) To induce currents in a conductor, there must be relative motion between conductor and magnet of such a kind as to alter the number of lines of force embraced in the circuit.

FIG. 12.



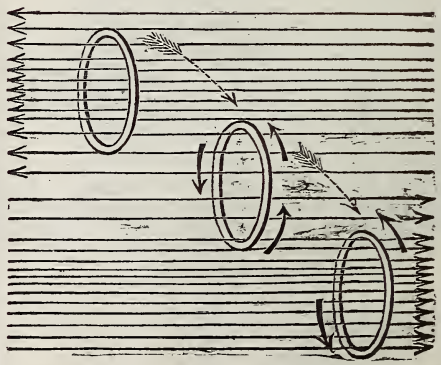
CIRCUIT MOVED SO AS TO ALTER NUMBER OF LINES OF FORCE THROUGH IT.

(6.) Increase in the number of lines of force embraced by the circuit produces a current in the opposite sense to decrease.

(7.) Approach induces an electromotive force in the opposite direction to that induced by recession.

(8.) The more powerful the magnet pole or

FIG. 13.



MOTION OF CIRCUIT IN NON-UNIFORM MAGNETIC FIELD.

magnetic field, the stronger will be the current generated (other things being equal).

(9.) The more rapid the motion, the stronger will be the currents.

(10.) The greater the length of the moving conductor thus employed in cutting lines of force (*i.e.*, the longer the bars, or the more

numerous the turns of the coil), the stronger will be the currents generated.

(11.) The shorter the length of those parts of the conductor not so employed, the stronger will be the current.

(12.) Approach being a finite process, the method of approach and recession (of a coil towards and from a magnet pole) must necessarily yield currents alternating in direction.

(13.) By using a suitable commutator, all the currents, direct or inverse, produced during recession or approach, can be turned into the same direction in the wire that goes to supply currents to the external circuits, thereby yielding an almost uniform current.

(14.) In a circuit where the flow of currents is steady* it makes no difference what kind of magnets are used to procure the requisite magnetic field, whether permanent steel magnets or electro-magnets, self-excited or or otherwise.

(15.) Hence the current of the generator may be itself utilised to excite the magnetism of the field-magnets, by being caused, wholly or partially, to flow round the field-magnet coils.

A very large number of dynamo-electric machines have been constructed upon the foregoing principles. The variety is indeed so great, that classification is not altogether easy. Some have attempted to classify dynamos according to certain constructional points, such as whether the machine did or did not contain iron in its moving parts (which is a mere accident of manufacture, since almost all dynamos will work either with or without iron in their armatures, though not equally well); or whether the currents generated were direct and continuous, or alternating (which is in many cases a mere question of arrangement of parts of the commutator or collectors); or what was the form of the rotating armature (which is, again, a matter of choice in construction, rather than of fundamental principle). The classification which I shall adopt, is one which I have found more satisfactory and fundamental than any other. I distinguish three genera or main classes of dynamos.

Class I.—Dynamos in which there is rotation of a coil or coils in a uniform† field of force, such rotation being effected (as in the manner indicated in Fig. 12, p. 124), round an axis in the plane of the coil, or one parallel to to such an axis.

Examples.—Gramme, Siemens (Alteneck), Edison, Lontin, Bürgin, Fein, Schückert, Jürgensen (Thomson's Mousemill-dynamo), [Brush].

Class II. — Dynamos in which there is translation* of coils to different parts of a complex field of varying strength, or of opposite sign. Most, but by no means all, of the machines of this class furnish alternate currents.

Examples. — Pixii, Clarke, Niaudet, Wallace-Farmer, Wilde (alternate), Siemens (alternate), Hopkinson and Muirhead, Thomson (alternate). Gordon (alternate), Siemens-Alteneck (Disk Dynamo), Edison (Disk Dynamo), De Meritens.

Class III.—Dynamos having a conductor rotating so as to produce a continuous increase in the number of lines of force cut, by the device of sliding one part of the conductor on or round the magnet, or on some other part of the circuit.

Examples.—Faraday's Disk-machine, Siemens's ("Unipolar" Dynamo), Voice's Dynamo.

One machine, and one only, am I aware of, which does not fall exactly within any of these classes,† and that is the extraordinary tentative dynamo of Edison, in which the coils are waved to-and-fro at the ends of a gigantic tuning-fork, instead of being rotated on a spindle.

Suppose, then, it were determined to construct a dynamo upon any one of these plans—say the first—a very slight acquaintance with Faraday's principle and its corollaries

* For currents that are not steady, there are other considerations to be taken into account, as will be shown hereafter.

† Or approximately uniform. A Gramme ring, or a Siemens drum armature, will work in a by no means uniform field, but is adapted to work in a field in which the lines of force run uniformly from one side to the other. But in such a field, a multipolar armature of many coils, such as that of Wilde, or such as is used in the Gramme alternate-current, or in the Siemens alternate-current machine, is useless and out of place. Indeed, the classification almost amounts to saying that in machines of Class I. there is one field of force, while in machines of Class II. there are many fields of force, or the whole field of force is complex.

* The motion by which the individual coils are carried round on such armatures as those of Niaudet, Wallace-Farmer, Siemens (alternate), &c., is, of course, not a pure translation. It may be regarded, however, as a combination of a motion of translation of the coil round the circumference of a circle, with a rotation of the coil round its own axis, which, as we have seen above, has *no* electrical effect. It is, of course, the translation of the coil to different parts of the field which is the effective motion.

† There are a few dynamos, including the Elphinstone Vincent, and the four-pole Gülcher, which, though really belonging to the first class, are not named above, because they are, in reality, compound machines. The Gülcher, with its doubled field magnets and four collecting brushes, is really a double machine, though it has but one rotating ring. The same is the case with an octagonal-pattern Gramme, which has four brushes. The Elphinstone-Vincent machine, a remarkable one in many respects, is a triple machine, having six brushes; and may, indeed, be used as three machines, to feed three separate circuits.

would suggest that, to obtain powerful electric currents, the machine must be constructed upon the following guiding lines:—

(a.) The field-magnets should be as strong as possible, and their poles as near together as possible.

(b.) The armature should have the greatest possible length of wire upon its coils.

(c.). The wire of the armature coils should be as thick as possible, so as to offer little resistance.

(d.) A very powerful steam-engine should be used to turn the armature, because,

(e.) The speed of rotation should be as great as possible.

Unfortunately, it is impossible to realise all these conditions at once, as they are incompatible with one another; and, moreover, there are a great many additional conditions to be observed in the construction of a successful dynamo. We will deal with the various matters in order, beginning with the speed of the machine.

Relation of Speed to Power.

Theory shows that, if the intensity of the magnetic field be constant, the electromotive force should be proportional to the speed of the machine. Numerous experiments, by many different workers, have shown that this is true, within certain limits, for those machines in which the field magnets are independent of the main circuit, that is to say, for magneto and separately-excited dynamos. It is not, however, quite exact, unless the resistance of the circuit be increased proportionately to the speed, because the current in the coils itself re-acts on the magnetic field, and alters the distribution of the lines of force. The consequence of this reaction is that, firstly, the position of the "diameter of commutation" is altered; and, secondly, the effective number of lines of force is reduced. So that, with a constant resistance in circuit, the electromotive force, and therefore the current, are slightly less at high speeds than the proportion of the velocities would lead one to expect. Since the product of current into electromotive force gives a number proportional to the electric work of the machine, it follows that, for "independently excited" machines, the electric work done in given time is nearly proportional to the square of the speed, and the work drawn from the steam-engine will be similarly proportional to the square of the speed.

In self-exciting machines, whether "series" or "shunt" in their arrangements, a wholly different law obtains. If the iron of the field-magnets be not magnetised near to saturation, then, since the increase of current consequent on increase of speed produces a nearly proportional increase in the strength of the magnetic field, this increase will react on the electromotive force, and cause it to be proportional more nearly to the square of the velocity, which again will cause the current to increase in like proportion. But since the magnetisation of the iron is, even when far from saturation point, not exactly proportional to the magnetising force, but something less, it is in practice found that the electric work of the machine is not proportional to the fourth power of the speed, is not even proportional to the third power of the speed, but to something slightly less than the latter.

As mechanical considerations forbid too high a velocity in the moving parts, it is clear that, if there be a limiting speed at which it is safe to run any given armature, the greatest amount of work will be done at that speed by using the most powerful magnets possible, namely, electro-magnets rather than magnets of steel.

Marcel Deprez has shown* that it is convenient to study the action of dynamos, by constructing a curve which he calls a "characteristic," shewing, for any given speed, the relation between electromotive force and strength of current generated in a circuit of given resistance. Amongst other conclusions, M. Deprez has found that for every dynamo there is a certain speed, which we may call the "critical speed," at which, no matter what the current is which circulates in the coils of the field magnets, the electromotive force is proportional to the strength of that current; and he bases upon the discovery of this critical speed two methods of utmost importance in practice, for obtaining, automatically, either a constant electromotive force or a constant current at will, in a circuit in which the resistances are varied to any degree.

In all these combinations, however, everything depends upon the condition that the driving speed shall be uniform. For all the best kind of electric work, a gas-engine is wholly out of the question as a source of power, because of its extreme inequalities in speed. Even with the best steam-engines, a specially sensitive valve is required; and probably such

* *Comptes Rendus*, 1881, and elsewhere. For an excellent summary of the work of M. Deprez, see *La Lumière Electrique*, February 18, 1882.

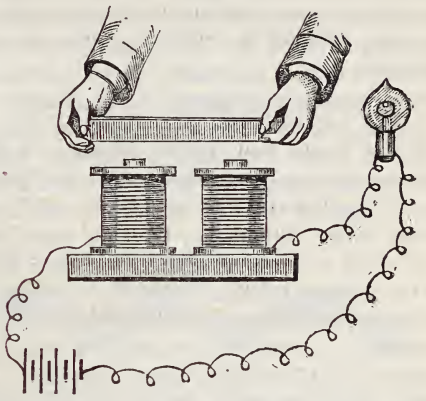
valves will, in the future, be operated electrically by self-acting electro-magnet gearing. In any case, where the driving is at all liable to be uneven, the obvious and simple precaution should be taken of placing a heavy fly-wheel on the axis of the dynamo. It is, indeed, singular that this is not more generally done.

Field-magnets.

The coils of the field-magnets of a dynamo cannot be constructed of no resistance. They, therefore, always waste some of the energy of the currents in heat. It has, therefore, been argued that it cannot be economical to use electro-magnets in comparison with permanent magnets of steel, which have only to be magnetised once for all. Nevertheless, there are certain considerations which tell in favour of electro-magnets. For equal power, their prime cost is less than that of steel magnets, which, moreover, are not permanent, but require remagnetising at intervals. Moreover, as we have seen, from the fact that there is a limiting velocity at which it is safe to run a machine, it is important, in order not to have machines of needlessly great size, to use the most powerful field-magnets possible. But if we do not get our magnetism for nothing, and find it more convenient to spend part of our current upon the electro-magnets, economy dictates that we should so construct them that their magnetism may cost us as little as possible. To magnetise a piece of iron requires the expenditure of energy; but when once it is magnetised, it requires no further expenditure of energy (save the slight loss by heating in the coils, which may be reduced by making the resistance of the coils as little as possible) to keep it so magnetised, provided the magnet is doing no work. Even if it be doing no work, if the current flowing round it be not steady, there will be loss. If it do work, say, in attracting a piece of iron to it, then there is an immediate and corresponding call upon the strength of the current in the coils, to provide the needful energy. This point may be illustrated by the following experiment:—Let a current from a steady source (see Fig. 14) pass through an incandescent lamp, and also through an electro-magnet, whose cores it magnetises. When once established, the current is perfectly steady, and none of its energy is wasted on the magnet (save the negligible trifle due to the resistance of the coils). But if now the magnet is allowed to do work in attracting an iron bar toward itself, the light of the lamp is seen momentarily to fade. When the iron bar is snatched away, the light exhibits a momentary increase; in each case resuming its original intensity when the motion ceases. Now, in a dynamo where, in many cases, there are revolving parts containing iron, it is of importance that the approach of a recession of the iron parts should not produce such reactions as these in the magnetism of the magnet. Large, slow-acting field-magnets are therefore advisable. The following points embody the conditions for attaining the end desired.

(*a.*) The body of the field-magnets should be solid. Even in the iron itself currents are induced, and circulate round and round whenever the strength of the magnetism is altered. These self-induced currents tend to retard all

Fig. 14.



Reaction of Moving Mass of Iron on an Electro-Magnet.

changes in the degree of magnetisation. They are stronger in proportion to the square of the diameter of the magnet, if cylindrical, or to its area of cross-section. A thick magnet will, therefore, be a slow-acting one, and will steady the current induced in its field.

(*b.*) Use magnets having in them plenty of iron. It is important to have a sufficient mass, that saturation may not be too soon attained.

(*c.*) Use the softest possible iron for field-magnets, not because soft iron magnetises and demagnetises quicker than other iron (that is here no advantage); but because soft iron has a higher magnetic susceptibility than other iron—is not so soon saturated.

(*d.*) Use long magnets. Again, the use of long magnets is to steady the magnetism, and therefore to steady the current. A long magnet takes a longer time than a short

magnet to magnetise and demagnetise. It costs more than a short magnet, it is true, and requires more copper wire in the exterior coil; but the copper wire may be made thicker in proportion, and will offer less resistance. The magnetism so obtained should be utilised as directly as possible, therefore

(*e.*) Place the field-magnets or their pole-pieces as close to the rotating armature as is compatible with safety in running.

(*f.*) Avoid edges and corners on the magnets and pole-pieces if you want a uniform field. The laws of distribution of the magnetic lines of force round a pole are strikingly akin to those of the distribution of electrification over a conductor. We avoid edges and points in the latter case, and ought to do in the former. If the field-magnets or their pole-pieces have sharp edges, the field cannot be uniform, and some of the lines of force will run uselessly through the space outside the armature instead of going through it. Theoretically, the very best form to give externally to a magnet is that of the curves of the magnetic lines of force.

(*g.*) Reinforce the magnetic field by placing iron, or better still, electro-magnets, within the rotating armature. In many cases this is done by giving the armature coils iron cores which rotate with them; in other cases, the iron cores or internal masses are stationary. In the former case there is loss by heating; in the latter, there are structural difficulties to be overcome. Siemens has employed a stationary mass within his rotating drum-armature. Internal electro-magnets serving the function of concentrating the magnetism of the field, and of so providing a continuous magnetic circuit, have been used by Lord Elphinstone and Mr. Vincent. A similar device obtains in Sir W. Thomson's "mouse-mill" dynamo, and in Jürgensen's dynamo.

(*h.*) In cases where a uniform magnetic field is not desired, but where, as in dynamos of the second class, the field must have varying intensity at different points, it may be advisable specially to use field-magnets with edges or points, so as to concentrate the field at certain regions.

Pole-pieces.

(*i.*) The pole-pieces should be heavy, with plenty of iron in them, for reasons similar to those urged above.

(*j.*) The pole-pieces should be of shapes really adapted to their functions. If intended to form a single approximately uniform field, they should not extend too far on each side. The distribution of the electromotive force in the various sections of the coils on the armature depends very greatly on the shape of the pole-pieces.

(*k.*) Pole-pieces should be constructed so as to avoid, if possible, the generation in them of useless Foucault currents. The only way of diminishing loss from this source is to construct them of laminæ, built up so that the mass of iron is divided by planes in a direction perpendicular to the direction of the currents, or of the electromotive forces tending to start such currents.

(*l.*) If the bed-plates of dynamos are of cast-iron, care should be taken that these bed-plates do not short-circuit the magnetic lines of force from pole to pole of the field-magnets. Masses of brass, zinc, or other non-magnetic metal may be interposed; but are at best a poor resource. In a well-designed dynamo, there should be no need of such devices.

Field-magnet Coils.

(*m.*) In order to be of the greatest possible service, the coils of the field-magnets should be wound on most thickly at the middle of the magnet, not distributed uniformly along its length, nor yet crowded about its poles. The reason for this is two-fold. Inspection of Fig. 6 (p. 122) will show that many of the lines of force of a magnet "leak out" from the sides of the magnet before reaching its poles, where they should all emerge if the mass of the magnet were perfectly equally magnetised throughout its whole length. Internally, the magnetisation of the magnet is greatest at its centre. At, or near the centre, therefore, place the magnetising coils, that the lines of force due to them may run through as much iron as possible. The second reason for not placing the coils at the end is this; any external influence which may disturb the magnetism of a magnet, or affect the distribution of its lines of force, affects the lines of force in the neighbourhood of the pole far more than those in any other region. It is for this reason that in Bell's telephones, where it is desired to make a magnet most sensitive to variations in intensity, the coils are fixed on at the pole. In the field-magnet of a dynamo, on the contrary, where the magnet is wanted to be as steady and constant as possible in its magnetic power, the coils should not be placed on the poles.

(*n.*) The proper resistances to give to the field-magnet coils of dynamos have been calculated by Sir Wm. Thomson,* who has given the following results:—

* British Association Report, 1881, p. 528

For "Series Dynamo," make the resistance of the field-magnets a little less than that of the armature. Both of them should be small, compared with the resistance of the external circuit. The ratio of the waste by heating in the machine, to the total electric work of the machine, will be—

$$\frac{\text{waste :}}{\text{total work}} = \frac{R_M + R_A}{R_M + R_A + R_X}$$

and $$\frac{\text{useful work}}{\text{total work}} = \frac{R_X}{R_M + R_A + R_X}$$

where R_M i the resistance of the magnets,
R_A ,, ,, of the armature,
R_X ,, ,, of the external circuit.

For a "Shunt Dynamo," the rule is different. The best proportions are when such that

$$R_X = \sqrt{R_M R_A} \text{ or that}$$
$$R_M = \frac{R_X^2}{R_A}$$

also the ratio of useful work is :—

$$\frac{\text{useful work}}{\text{total work}} = \frac{1}{1 + 2\sqrt{\frac{R_A}{R_M}}}$$

An example of the latter may be of advantage. Suppose it was wished that the waste should not be more than 10 per cent. of the useful work, the ratio of the formula must equal $\frac{10}{11}$, or $1 \div 1\frac{1}{10}$. Hence $\sqrt{\frac{R_A}{R_M}}$ must equal $\frac{1}{20}$; or R_M the resistance of the field-magnets must be 400 times R_A that of the armature.

Armature Cores.

(*o.*) Theory dictates that if iron is employed in armatures, it must be slit or laminated, so as to prevent the generation of Foucault currents. Such iron cores should be structurally divided in planes normal to the circuits round which electromotive force is induced; or should be divided in planes parallel to the lines of force and to the direction of the motion. Cores built up of varnished iron wire, or of thin disks of sheet-iron separated by varnish, asbestos paper, or mica, partially realise the required condition.

(*p.*) Armature cores should be so arranged that the direction of polarity of their magnetisation is never abruptly reversed during their rotation. If this precaution is neglected, the cores will be heated.

Armature Coils.

(*q.*) All needless resistance should be avoided in armature coils, as hurtful to the efficiency of the machine. The wires should therefore be as short and as thick as is consistent with obtaining the requisite electromotive force, without requiring an undue speed of driving.

(*r.*) The wire should be of the very best electric conductivity. The conductivity of good copper is so nearly equal to that of silver (over 96 per cent.), that it is not worth while to use silver wires in the armature coils of dynamos.

(*s.*) In cases where rods or strips of copper are used instead of mere wires, care must be taken to avoid Foucault currents by laminating such conductors, or slitting them in planes parallel to the electromotive force, that is to say, in planes perpendicular to the lines of force, and to the direction of the rotation.*

(*t.*) In dynamos of the first class, when used to generate currents in one direction, since the currents generated in the coils are doing half their motion inverse to those generated during the other half of their motion, a commutator or a collector of some kind must be used. In any single coil without a commutator, the alternate currents would be generated in successive revolutions, if the coil were destitute of self-induction currents, whose variations may be graphically expressed by a recurring sinusoidal curve, such as Fig. 15. But if by the addition

Fig. 15.



of a simple split-tube commutator the alternate halves of these currents are reversed, so as to rectify their direction through the rest of the circuit, the resultant currents will not be continuous, but will be of one sign only, as shown in Fig. 16, there being two currents generated

Fig. 16.



during each revolution of the coil. If two coils are used, at right-angles to each others' planes, so that one comes into the position of best action, while the other is in the position of least action (one being normal to the lines of force, when the other is parallel to them), and their actions be superposed, the result will be, as shown in Fig 17 (p. 130), to give a current

* It will be observed that the rule for eliminating Foucault currents is different, in the three cases, for magnets and their pole-pieces, for moving iron armature cores, and for moving conductors in the armature.

which is continuous, but not steady, having four slight undulations per revolution. If any number of separate coils are used, and their effects, occurring at regular intervals, be superposed, a similar curve will be obtained, but with summits proportionately more numerous and less elevated. When the number of coils used is very great, and the overlappings of the curves still more complete, the row of summits will form practically a straight line, or the whole current will be practically constant.

(*u.*) The rotating armature coils ought therefore to be divided into a large number of sections, each coming in regular succession into the position of best action.

(*v.*) If these sections, or coils, are independent of each other, each coil, or diametral pair of coils, must have its own commutator. If they are not independent, but are wound on in continuous connexion all round the armature, a collector is needed, consisting of parallel

Fig. 17.



metallic bars as numerous as the sections, each bar communicating with the end of one section and the beginning of the next.

(*w.*) In any case, the connexions of such sections and of the commutators, or collectors, should be symmetrical round the axis; for if not symmetrical, the induction will be unequal in the parts that successively occupy the same positions with respect to the field-magnets, giving rise to inequalities in the electromotive force, sparking at the commutator, or collector, and other irregularities.

(*x.*) In the case where the coils are working in series, it is advantageous to arrange the commutator to cut out the coil that is in the position of least action, as the circuit is thereby relieved of the resistance of an idle coil. But no such coil should be short-circuited to cut it out. In the case where the coils are working in parallel, cutting out an idle coil increases the resistance, but may be advisable to prevent heating from waste currents traversing it from the active coils.

(*y.*) In the case of pole-armatures, the coils should be wound on the poles rather than on the middles of the projecting cores; since the variations in the induced magnetism are most effective at or near the poles. (See § *m*, p. 128.)

(*z.*) Since it is impossible to reduce the resistance of the armature coils to zero, it is impossible to prevent heat being developed in those coils during their rotation; hence it is advisable that the coils should be wound with air spaces in some way between them, that they may be cooled by ventilation.

(*aa.*) The insulation of the armature coils should be ensured with particular care, and should be carried out as far as possible with mica and asbestos, or other materials not liable to be melted, if the armature coils become heated.

Commutators, Collectors, and Brushes.

(*ab.*) Commutators and collectors being liable to be heated through imperfect contact, and liable to be corroded by sparking, should be made of very substantial pieces of copper.

(*ac.*) In the case of a collector made of parallel bars of copper, ranged upon the periphery of a cylinder, the separate bars should be capable of being removable singly, to admit of repairs and examination.

(*ad.*) The brushes should touch the commutator or the collector at the two points, the potentials of which are respectively the highest and the lowest of all the circumference. In a properly and symmetrically built dynamo, these points will be at opposite ends of a diameter.

(*ae.*) In consequence of the armature itself, when traversed by the currents, acting as a magnet, the magnetic lines of force of the field will not run straight across, from pole to pole, of the field-magnets, but will take, on the whole, an angular position, being twisted a considerable number of degrees in the direction of the rotation. Hence the diameter of commutation (which is at right-angles to the resultant lines of force in machines of the Siemens and Gramme type, and parallel to the resultant lines of force in machines of the Brush type), will be shifted forward. In other words, the brushes will have a certain angular lead. The amount of this lead depends upon the relation between the intensity of the magnetic field and the strength of the current in the armature. This relation varies in the four different types of field-magnets. In the series dynamo, where the one depends directly on the other, the angle of lead is nearly constant, whatever the external resistance. In other forms of dynamo, the lead will not be the same, because the variations of resistance in the external circuit do not produce a proportionate variation between the two variables which determine the angle of lead.

(af.) Hence in all dynamos it is advisable to have an adjustment, enabling the brushes to be rotated round the commutator or collector, to the position of the diameter of commutation for the time being. Otherwise there will be sparking at the brushes, and in part of the coils at least the current will be wasting itself by running against an opposing electromotive force.

(ag.) The arrangements of the collector, or commutator, should be such that, as the brushes slip from one part to the next, no coil or section in which there is an electromotive force should be short circuited, otherwise work will be lost in heating that coil. For this reason, it is well so to arrange the pole-pieces that the several sections or coils on either side of the neutral position should differ but very slightly in potential from one another.

(ah.) The number of contact points between the brushes and the collector, or commutator, should be as numerous as possible, for by increasing the number of contacts, the energy wasted in sparks will be diminished inversely as the square of that number. The brushes might, with advantage, be laminated, or made of parallel loose strips of copper, each bearing edgeways on the collector.

Relation of Size to Efficiency.

The efficiency of a dynamo-electric machine is the ratio of the useful electrical work done by the machine to the total mechanical work applied in driving it. Every circumstance which contributes to wasting the energy of the current reduces the efficiency of the machine. In the preceding paragraphs it has been shown what the chief electric sources of waste are, and how they may be avoided. The precautions needful to obviate Foucault currents, to avoid reversals of magnetisation, to get rid of needless resistance, to obviate opposing electromotive forces, have been detailed. Mechanical friction of the moving parts can be minimised also by due mechanical arrangements. But one thing cannot be entirely obviated, because even the best conductors employed have a certain resistance. We cannot prevent the heating of the conducting coils; and the more powerful the current generated by the machine, the more important does this source of waste become. There is but one way to reduce this, and that is by increasing the size of the machines. For some three years or so I have been the advocate of large dynamo machines, not because I have any admiration for mere bigness, but because, as in steam-engines so in dynamos, the larger machines may be made more efficient than the small, in proportion to their cost. In discussing the relation of size to efficiency, I shall assume, for the sake of argument, that the size of any machine can be increased n times in every dimension, and that though the dimensions are increased, the velocity of rotation remains the same, and that the intensity of the magnetic field, per square centimetre, remains also constant. If the linear dimensions be n times as great in the larger machine as in the smaller, the area it stands on will be increased n^2 times, and its volume and weight n^3 times. The cost will be less than n^3 times but greater than n times. If the same increase of dimensions in the coils be observed (the number of layers and of turns remaining the same as before), there will be in the armature coils a length n times as great, and the area of cross-section of the wire will be n^2 times as great as before. The resistance of these coils will, therefore, be but $\frac{1}{n}$ part of the original resistane of the smaller machine. If the field-magnet coils are increased similarly they will offer only $\frac{1}{n}$ of the resistance of those of the smaller machine. Moreover, seeing that while the speed of the machine is the same, the area cut through by the rotating coils is increased n^2 times, these coils will in the same time cut n^2 times as many lines of force, or the electromotive force will be increased n^2 times. Supposing the whole of the circuit to be similarly magnified, its resistance will also be but $\frac{1}{n}$ of the previous value.

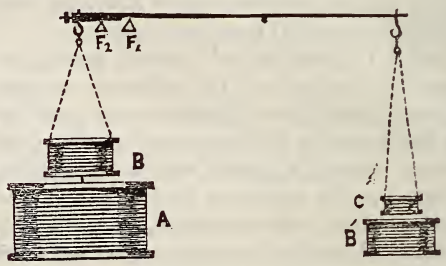
If the machine is a "series"-wound dynamo, an electromotive force, n^2, working through $\frac{1}{n}$ resistance will give a current n^3 times as great as before. Such a current will, as a matter of fact, much more than suffice to bring up the magnetic field to the required strength, viz., n^2 times the area of surface magnetised to the same average intensity per square centimetre, as stipulated; for the mass of iron being n^3 times as great, it need not be so much saturated as before to give the required field. Here an economy may be effected, therefore, by further reducing the number of coils, and therefore the wasteful resistance of the field-magnet coils, in the proportion of n^3 to n^2, or to $\frac{1}{n}$ of its already diminished value. Even if this were not done, by the

formula given above for the electrical efficiency of a "series" dynamo, the waste, when working through a constant external resistance, will be n-fold less than with the smaller machine. Now, if the current be increased n^3 times, and the electro-motive force n^2 times, the total electric work which is the product of these will be n^5 times greater than in the small machine, and it will consume n^5 times as much power to drive it.* It is clearly an important economy, if a machine costing less than n^3 times as much, will do n^5 times as much work (to say nothing of the increased ratio of efficiency). A machine doubled in all its linear dimensions will not cost eight times as much, and will be electrically thirty-two times as powerful a machine.

Suppose the machine to be "shunt" wound, then to produce the field of force of n^2 times as many square centimetres area, will require (if the electromotive force be n^2 times as great) that the absolute strength of the current remain the same as before in the field-magnet coils. This can be done by using the same sized wire as before, and increasing its length n^2 times, to allow for n times as many turns, of n times as great a diameter each, in the same number of layers of coils as before. In this case the work done in the shunt being equal to the product of the n^2-fold electromotive force into the unaltered current will be only n^2 times as great, while the whole work of the machine is augmented n^5 times. Now, if while augmenting the total work n^5 times, we have increased the waste work not to n^5 times but only n^2 times, it is clear that the ratio of waste to the total effect is diminished n^3-fold. There is, therefore, every reason to construct large machines, from the advantage of economy, both in relative prime cost and relative efficiency.

Being desirous of testing the correctness of the deduction that the working capacity of a machine of n-fold linear dimensions is n^5 times as great, I constructed a little instrument, of which a drawing is given in Fig. 18. In this

FIG. 18.



S. P. THOMPSON'S EXPERIMENTAL BALANCE.

instrument there are two pairs of coils, that on the left being, in every way, the counterpart of that on the right, but of double linear dimensions. When all four coils were traversed by the same current, the point of equilibrium was $\frac{1}{17}$ of the length of the beam from the extremity; or the attraction of the larger system was sixteen times that of the smaller. Now, it is clear that the larger force can be exerted through double the distance, or that the work-power is 32-fold, and 32 is 2^5, as theory requires. After I had constructed my apparatus, I learned that M. Marcel Deprez had made a very similar arrangement, but without the beam, to prove that the statical forces of similar machines are (see footnote *ante*) proportional to the fourth power of the linear dimensions. M. Deprez's instrument consisted of a modified Mascart's electro-dynamometer, having a coil suspended from a balance, and acted upon by two others, placed axially above and below it (see Fig. 19, p. 133). The force was measured by directly balancing it against weights. Two such arrangements were made, one double the size of the other, and when equal currents were sent through them, M. Deprez found the forces to be as

* This calculation agrees with the result deduced on entirely different principles by M. Marcel Deprez. M. Deprez considers the mutual reaction, dF, between two elements, ds and ds', of a system of conductors which, by Ampère's principle, is

$$dF = C^2 \frac{ds\, ds'}{r^2} f(\alpha)$$

where C is the current, r the distance of the elements apart, and $f(\alpha)$ a certain function of the machine, independent of its size. Writing a^2 for the area, we have

$$dF = \frac{C^2}{a^2} \cdot \frac{a^2 ds \,.\, a^2 ds'}{r^2} \cdot f(\alpha)$$
$$= \frac{C^2}{a^2} \cdot \frac{dv \,.\, dv'}{r^2} \cdot f(\alpha)$$

which, if the linear dimensions be increased n times, becomes

$$dF' = \frac{C^2}{a^2} \cdot \frac{n^3 dv \,.\, n^3 dv'}{n^2 r^2} \cdot f(\alpha)$$
$$= n^4 dF$$

whence, since this is true for all elements of the circuits, $\frac{F'}{F} = n^4$, which is Deprez's so-called "law of similars," which asserts that for similar machines the "statical effort" increases as the fourth power of the linear dimensions. But work W = F × distance, and, in the similar machine whose dimensions are increased n times, the available distance through which the force F' can act is also n times greater. Hence $\frac{W'}{W} = n^5$, as above.

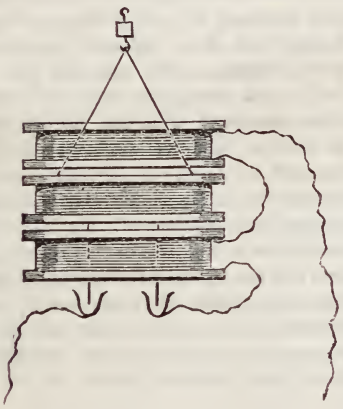
5·600 to 0·355 kilos., or almost exactly 16 to 1.

Methods of Exciting the Field Magnetism.

It only remains to develop certain theoretical considerations respecting the method of exciting the magnetism of the field, in which the armatures are to revolve. The four main methods have already been alluded to at the outset of this lecture; but nothing has been said about the advantages or disadvantages of the four systems.

Magneto - Dynamos. — The magneto-dynamos (Fig. 4, p. 121) have the advantage in theory at least, that their electromotive force is very nearly exactly proportional to the velocity of rotation; though, of course, the

Fig. 19.



Marcel Deprez's Electrodynamic Balance.

variable difference of potential between the terminals of the circuit will depend on the relation of the resistance of the external circuit to the internal resistance of the armature coils. They possess the disadvantage that, since steel cannot be permanently magnetised to the same degree as that which soft iron can temporarily attain, they are not so powerful as other dynamos of equal size.

Separately-Excited Dynamos.—The separately excited dynamo (Fig. 3, p. 120) has the same advantage as the magneto-machine, in electromotive force being independent of its accidental changes of resistance in the working circuit, but is more powerful. It has, moreover, the further advantage that the strength of the field is under control. For by varying either the electromotive force or the resistance in the exciting circuit, the strength of the magnetic field is varied at will. It has the disadvantage of requiring a separate exciting machine.

Series Dynamos.—The ordinary, or series dynamo (Fig. 1, p. 119), is usually a cheaper machine, for equal power, than any of the other forms, as its coils are simpler to make than those of a shunt machine, and it wants no auxiliary exciter. It has the disadvantages of not starting action until a certain speed has been attained, or unless the resistance of the circuit is below a certain minimum. It is also liable to become reversed in polarity, a serious disadvantage when this machine is applied for electro-plating or for charging accumulators.

From its arrangements, it is clear that any increase of the resistance in the circuit lessens its power by diminishing the strength of its magnetic field. Hence it is better adapted for use with lamps arranged in parallel arc than for lamps arranged in series. An additional lamp switched in, in series, adds to the resistance of the circuit, and diminishes the power of the machine to supply current. While on the other hand, an additional lamp in parallel reduces the total resistance offered by the network of the circuit, and adds to the power of the machine to provide the needed current. It is easy to regulate the currents given by a series dynamo, by introducing a shunt of variable resistance across the field-magnet, thus altering the magnetising influence of the current.

Shunt Dynamos.—The shunt dynamo (Fig. 2, p. 120) has several advantages over other forms. It is less liable to reverse its polarity than the series dynamo, and it is commonly considered as providing the magnetising power to the magnets with less waste of current. Moreover, for a set of lamps in series, its power to supply the needful current increases with the demands of the circuit, since any added resistance sends additional current round the shunt in which the field-magnets are placed, and so makes the magnetic field more intense. On the other hand, there is a greater sensitiveness to inequalities of driving in consequence of the great self-induction in the shunt. As previously pointed out, when there are sudden changes in the electromotive force acting in a complex circuit, the momentary currents thus set up do not distribute themselves in the various parts of the circuit in the simple inverse ratio of the resistances, for their distribution depends also, and in some cases

chiefly, upon the self-induction in the various parts. It is more difficult to set up a sudden current in a circuit whose self-induction is great (or which, for example, consists of many turns wound closely together, so that they exercise great inductive action on each other, especially if they be wound about an iron core) than in one in which the self-induction is small. We cannot here follow further the mathematical law of the action of self-induction on momentary changes of electromotive force. But the application to the shunt-wound dynamo is too important to be passed over.

Any of these systems may be applied either in direct current or in alternate-current machines. Each of these four systems of exciting the field magnetism has its own merits for special cases, but none of them is perfect. Not one of these methods will insure that, with a uniform speed of driving, either the electromotive force or the current shall be constant, however the resistances of the circuit are altered.

But, though theory tells us that none of these systems is perfect, theory does not leave us without a guide. Thanks to the genius of M. Marcel Deprez, we have been taught how to combine these methods so as to secure in practice a machine which shall, when driven at a constant speed, give either a constant electromotive force or a constant resistance. A consideration of the various methods of combining the four systems of exciting the field-magnetism is reserved for the lecture on the dynamo in practice.

Meantime, it may safely be said that there is no such thing yet as a best dynamo. As with the different kinds of voltaic batteries, some of which are used for telegraph work, others for electric bells, and others for blasting, so is it also with dynamos. One form is best for one purpose and another for another. One gives steadier currents, another is less liable to heat, a third is more compact, a fourth is cheaper, a fifth is less likely to reverse its currents, a sixth gives a greater volume of current, while a seventh evokes a higher electromotive force. Indeed, in the present transitional state of our knowledge with respect to dynamo-electric machinery, it is safe to assert that, for a long time to come, there will be no finality attained to. As with the steam-engine, however, so with the dynamo-machine, there will probably be a constant and progressive evolution, finally settling down upon two or three typical forms, which will survive the innumerable comparatively crude machines which, as yet, have taken shape and come into active service.

Miscellaneous.

PATENT OFFICE INDEXES.

The followiug particulars are taken from an article on "The Invention of the Steam-engine," in the January number of the *Antiquary* :—

The Patent Office Indexes commence with the year 1617, an arbitrary date, which seems to have been chosen from the fact that a certain record of grants under the Great Seal—known as the "Docquett Book"—was begun in that year. Notices of earlier grants must be sought in various indexes at the Public Record Office, and in the published Calendars of State Papers. The indexes also are not quite perfect for the period which they profess to cover, no notice being taken of petitions for protection, nor of grants of a less formal nature than "letters patent under the Great Seal." In those early days the practice was somewhat unsettled, and the royal protection was conferred in several different ways. It seems a pity that these old lists should not be made more complete. We are sure the Patent Office authorities recognise the fact that they have duties associated with the history of their work, as well as with its discharge at the present time, and we think we may fairly appeal to the Master of the Rolls, under whose authority so much admirable antiquarian work has been done, to turn his attention to the documents relating to the early history of the grants of monopolies for inventions before the statute of James, and by ordering the publication of such extracts from them as may be required, complete, once for all, the excellent series of works of this character issued by the Patent Office.

INDUSTRIAL ART EXHIBITION, GHENT.

The objects of the exhibition organised by the Chambre Syndicale des Arts Industriels de Gand, which was opened in August last, and has lately been closed, have already been set forth, and the classification of exhibits given in the *Journal*.*

There were twenty special competitions, divided under two series. First series—Drawing applied to Industry. Second series—Executed Works.

In the 2nd group of the Division I., Building, specimens of a new flooring were shown by M.M. Damman et Cassard, Brussels. It consists of stone flagging, laid on cement, and covered with a damp-proof composition, into which, while still soft, parquetry is fitted, the whole being consolidated together by dove-tail grooves, formed in the wood and conical holes in the masonry. This flooring possesses the advantages of stone, that is to say, solidity and non-resonance, without the coldness to the feet, while there is no space left underneath, as in timber

* August 11th, 1882, vol. xxx., p. 923.

flooring, in which vermin can harbour. It has been applied, among other buildings, to the Popular Library, Antwerp, and the Commercial Schools of Laeken, Molenbeek, and Anderlecht, all suburbs of Brussels. M. Ed. Suy, of Ghent, exhibited a specimen of forty veneers, sawn by his system, from a thickness of one inch.

There are many sun-blinds, which are claimed to keep in the position to which they are set, without any fastening; but they frequently get out of order in a short time. A very simple contrivance for this purpose of keeping sun-blinds in position without fastenings was shown by M. Nicholas Bulens, who received the Diploma of Honour, at Vienna, in 1873. An endless cord passes over the pulley at the end of the roller, as in the ordinary arrangement, but simply hangs loose, without weight or rack. A spring pressing upon the end of the roller performs the office of a brake, keeping it in the position to which it may be set; and thus resistance, which can be graduated, must be overcome in altering the position of the blind.

Ceramic ware comes under group 4, of Division II., Furniture and Decorations. Its most important exponent was Madame Vermeren-Coché, of Brussels, who has received the decoration of the Order of Leopold, for her services to this national industry. At the death of her husband, this lady, aided by her sister, took the management of the porcelain manufactory, and has since considerably enlarged the sphere of its operations, while at the same time raising the character of its products. New combinations are devised for each succeeding exhibition. This year the speciality consisted in decoration, over the glaze, with platinum and three shades of gold, burnished only in parts, while the rest is left dull. In some cases a kind of etching or engraving is given by means of the copper disc and emery, producing a remarkably artistic effect. Another novelty was *barbotine* in low relief on porcelain, produced by hand. This, brought up by gilding and colours, is also very effective. A special pavilion at the exhibition contained works of high artistic merit, all produced at the Brussels factory, which is the only one in the kingdom where the higher class of goods are made. The number of hands employed is nearly 150, including 16 painters on porcelain. Among the many amateurs and professional artists who contributed to this portion of the exhibition must be specially mentioned M. and Madame Dauge, Brussels, for the boldness of their execution, and Madame Noëmi Hemard, of Verviers, for extreme fidelity to nature in spite of the practical difficulties with vitrifiable colours.

In Division III., Metal Work, some interesting exhibits, consisted of light copper plates, shown by M. Charles Rossignol, of Bruges, illustrating the successive effects produced by the chisel and hammer in *repoussé* work, without the use of dies.

M. J. B. Fondu, of Vilvorde, showed a strong room door, fitted with several locks, actuated by separate keys, but capable of being opened all together by one master key, a combination which, it is asserted, has never before been accomplished.

Madame Belangé, Brussels, exhibited a new article in her "flambeau-applique," which consists of a candlestick, the shank of which slides freely in a socket attached to base, so that it will stand on a table like an ordinary candlestick, or may be suspended by attaching the base to a wall.

M. J. Van Der Meersh, Brussels, has succeded in plating various objects with nickel, a millimetre (0·039 inches) thick, whereas the ordinary thickness is from one to two hundredth parts of a millimetre. The letters of ordinary engraving do not cut completely through the coating; and a cornet-à-piston, exhibited in this Division, carries 84 grammes (1,296 troy grains) of nickel, whereas the ordinary process would only have deposited 3 grammes (46¼ grains).

In Division IV., Textile Fabrics, the work of the pupils of the Ecole Industrièlle de Gand (Special Section of Weaving), were good, consisting of mattress cloth, curtains, table-covers, and ornamental cloth for dados. In the coloured designs, full-size or larger, each thread is marked, so that the pattern shall be reproduced symmetrically. The exhibits reflect great credit, both on the pupils themselves, and on the director of the school, M. L. Bureau. The Ateliers d'Apprentissage, of West Flanders (Inspector, M. Van den Daele), contributed some good damask and other curtain stuffs and embroidery. M. R. Borreman, Ghent, who obtained a medal at the Sydney Exhibition, sent furniture stuffs, produced from silk, wool, cotton, and jute; and the Royal Carpet Manufactory of Tournai, contributed a handsome Smyrna carpet.

Division V. included typography and book-binding, of which there were some excellent examples. M. G. Vlietinck, Bruges, sent a work on the Industrial Exhibition of that city, in 1881, entitled, "Gedenkboek der Nijverheids-tentoonstelling Van West-Vlaanderen;" and M. H. F. Keuller, of Jette-St.-Pierre, a folio work on "Les Tapisseries Historiées de l'Exhibition Nationale Belge, en 1880." M. Claessens, Brussels, sent an interesting collection of book-bindings, from the year 1400 to the present time.

The catalogue* itself is a good specimen of printing, executed by M. E. Vanderhaenen, Ghent; it is also carefully compiled. The only fault is that there is no general index of exhibitors, so that to find any one it is necessary to know the division and group in which he exhibited.

Correspondence.

THE UTILISATION OF WASTE.

Mr. Hugh Clements sends the following remarks on Mr. Simmonds's paper :—

* A copy will be found in the Library.

"Although Mr. Simmonds, in his comprehensive paper on "The Utilisation of Waste," referred to the dried yeast of the Continent, he did not speak of the enormous quantities of brewers' yeast that was wasted here, or only partly utilised in the form of a compressed yeast, that was not nearly so effective in bread-making by fermentation as the German yeast imported from the Continent. Now, if it was possible for English brewers to produce an article equal to that supplied externally, the import of foreign yeast would cease, and more than half a million sterling would be free to be used for some other purpose, for the benefit of the people. In passing, I may say that a few years ago I was engaged in a variety of experiments, with a chemist, at one of the London breweries, in order to discover, if possible, the reason why the Continental was so much superior to the English compressed yeast. The exact nature of these experiments were described at the time in one of the scientific papers, and several other gentlemen stated the results of their experiments at breweries; but as the importation of yeast has not decreased to any appreciable extent, so far as I can ascertain, it must be concluded that no satisfactory process has yet been patented, although I have heard of several so-called *bonâ-fide* processes that were said to be successful. From a statistical inquiry that I made, which was published in the *Live Stock Journal*, of the 9th December, 1881, I am prepared to dispute Mr. Simmonds's statements as to the importation and consumption of meat in the United Kingdom. Mr. Simmonds states that we import more than 600,000 tons of meat every year, although the latest returns only give about 446,000 tons. Could he give a single instance in which that number was ever approached? Mr. Simmonds hints that the meat produce is decreasing in the United Kingdom, the fact being that it has been stationary—as I have shown elsewhere—during the last fifteen years at least. In 1867, the meat produce of the United Kingdom was 1,137,161; in 1871, 1,146,486; and, in 1882, 1,126,397 tons; all the intermediate years giving approximately 1,140,000 tons. Again, it is stated that the average consumption is 120 lbs. per head, whereas it does not exceed 98 lbs. at present. On page 103, Mr. Simmonds gives the quantity of straw used for paper in the United States, 30,000 tons in excess for 1880."

Obituary.

JOHN MARRIOTT BLASHFIELD.—Mr. Blashfield, who died on the 15th inst., had been a member of the Society of Arts since 1842, and was a frequent attendant at the evening meetings. He was also one of the original guarantors for the Great Exhibition of 1851. In 1836, he turned his attention to mosaic pavements, which he produced in coloured cement, and also in painted clay. Ornamental tiles at this time were made with wet clay, from moulds or dies, then dried and burnt—a slow process, and the tiles were liable to twist in drying and become distorted. In 1840, Prosser took out a patent for the manufacture of china buttons from dry powdered clay. Blashfield at once conceived the idea of making tessaræ and small tiles for pavements by a similar process, and put himself in communication with Prosser and Herbert Minton—who was then working Prosser's patent. The result was that ornamental tiles have since been made by this process. In 1843, Blashfield leased from the Crown a large portion of the Kensington Palace Estate, now known as Kensington-palace-gardens. He built the gate entrance, and many of the mansions. Later on, he commenced making pottery and architectural terra-cotta at Stamford, Lincolnshire, and there produced some fine works. Mr. Blashfield published several books on ornamental art, aided by his friends Owen Jones, Digby Wyatt, and others.

General Notes.

MUNICH ART EXHIBITION.—An International Art Exhibition, arranged by the Munich Artists' Association, will be opened at Munich in the spring of 1883. It will consist of works in painting, sculpture, and architecture, drawing, and works of art industry, if they are entitled by artistic invention and execution to rank as works of art. Works intended for exhibition must be sent to Munich, from the 1st to the 31st May.

TRANSMISSION OF POWER BY ELECTRICITY.—A novel application of the electrical transmission of power has lately been made at the Trafalgar Collieries, Forest of Dean. The electrical arrangements were carried out by the Pyramid Electric Company, under the supervision of their managing director, Mr. A. Le Neve Foster. In this case an electric motor is used to drive a pump in the underground workings. The pump is employed for pumping the drainage water from some of the deep workings to the bottom of the shaft, from whence the ordinary steam pumps raise it to the surface. The total vertical lift of the electric pump is 115 feet, whilst the length of pipes through which the water is forced is some 500 yards. A dynamo-machine is placed on the surface for generating the current for working the motor, and is connected to it by wires led down the shaft and along the workings, a distance of some 500 yards. Messrs. Brain, the proprietors of the collieries, express themselves perfectly satisfied with the result of the undertaking, and propose still further to extend the utilisation of electricity as a motive power.

Journal of the Society of Arts.

No. 1,572. Vol. XXX.

FRIDAY, JANUARY 5, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

The first of these lectures, on the "Inhabitants of the Ocean," was delivered by Professor Henry Nottidge Moseley, M.A., F.R.S., on Wednesday evening, the 3rd inst. The lecture was illustrated by a series of lantern slides of the different animals described, which were thrown on the screen by means of the lime-light. The lecturer dealt with the surface life as it appears far away from land, and he showed representative specimens of the immense variety of animal and vegetable life. He pointed out the structural difference between the surface and deep sea life, although there was reason to believe that, in a few instances, the young of the deep sea animals live on the surface, and only sink to the bottom when they are full-grown. The second lecture will treat of the deep sea life, and will be delivered on Thursday, January 10th, at seven p.m. As previously announced, all tickets are disposed of.

Proceedings of the Society.

CANTOR LECTURES.

DYNAMO-ELECTRIC MACHINERY.

By Professor Silvanus P. Thompson, B.A., D.Sc., M.S.T.E.

Lecture II.—Delivered December 11, 1882.

The Dynamo in Practice.

It was pointed out, at the conclusion of the former lecture, that none of the four fundamental methods of exciting the field-magnetism of a dynamo was perfect in theory, since none could enable a machine either to generate a constant current, or to maintain a constant electromotive force, whatever the resistance of the external circuit for the time being. Now, as the first function of a dynamo in practice is to feed with sufficiency and regularity a system of lamps, and as those lamps are always* in practice arranged either in series or in parallel, it is clear that in the former case a constant current, and in the latter a constant electromotive force, is required.

Combination Methods.

The discovery of the method of rendering a dynamo machine automatically self-adjusting, so that either its electromotive force (according to circumstances) shall be constant, is due to M. Marcel Deprez, and is a result of the considerations arising from the study of the diagrams of the characteristic curves of dynamos.† M. Deprez has, in fact, shown mathematically that if a dynamo be wound with a double set of coils, one of which can be traversed by an independent current, whilst the other set is traversed by the current of the machine itself, there can always be found a certain critical velocity of driving, for which, provided the field-magnets are far removed from their saturation point, the desired condition is fulfilled. Other combination methods have been suggested by Professor Perry and others; and, as the whole matter promises to be of utmost importance in the future practice of constructing dynamos, a summary of the principal methods may be worth tabulating.

(1.) *Series and Separate (for Constant E.M.F.), Deprez.*—This method, illustrated in Fig. 20 (p. 138), can be applied to any ordinary dynamo, provided the coils are such that a separate current from an independent source can be passed through a part of them, so that there shall be an initial magnetic field, independent of the main-circuit current of the dynamo. When the machine is running, the electromotive force producing the current will depend partly on this independent excitement, partly on the current's own excitement of the field-magnets. If the machine be run at such a speed that the quotient of the part of the electromotive force due to the self-excitement, divided by the strength of the current, is numerically equal to the internal resistance of the machinery, then the electromotive force in

* I am aware that occasionally incandescent lamps have been arranged with two or three lamps, in series, in each parallel, or on a multiple series plan. I am not aware of any such arrangement having been satisfactory.

† See *La Lumière Electrique*, December 3, 1881.

the circuit will be constant, however the external resistances are varied. M. Deprez has further shown that this velocity can be deduced from experiment, and that, when the critical velocity has once been determined, the machine can be adjusted to work at any desired electromotive force, by varying the strength of the separately-exciting current to the desired degree.

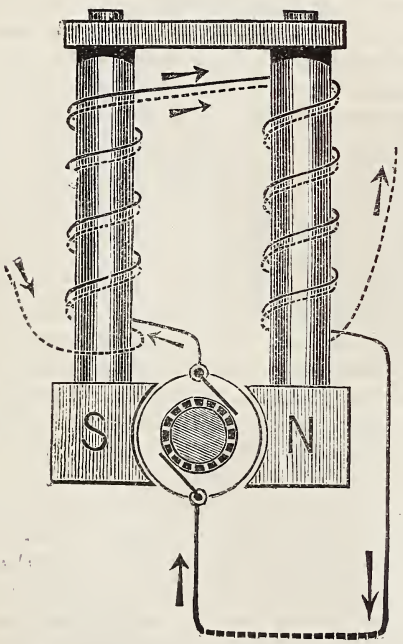
(2.) *Shunt and Separate (for Constant Current), Deprez.*—When cases arise, as for a set of arc lamps in series, it is desired to maintain the current in the circuit at one constant strength, the previous arrangement must be modified, as indicated in Fig. 21, by combining a shunt-winding with coils for a separately-exciting current. This arrangement is, in fact, that of a shunt-dynamo, with an initial magnetic field independent of the strength of the current in the circuit.

Seeing that the only object in providing the coils for separate excitement is to secure an initial and independent magnetic field, it is clear that other means may be employed to bring about a similar result.

(3.) *Series and Magneto (Constant E.M.F.), Perry.*—The initial electromotive force in the circuit, required by Deprez's theory, need not necessarily consist in there being an initial magnetic field of independent origin. It is true that the addition of a permanent magnet, to give an initial partial magnetisation to the pole-pieces of the field-magnets, would meet the case to a certain extent; but Professor Perry has adopted the more general solution of introducing into the circuit of a series-dynamo a separate magneto machine, also driven at a uniform speed, such that it produces in the circuit a constant electromotive force equal to that which it is desired should exist between the leading and return mains.*

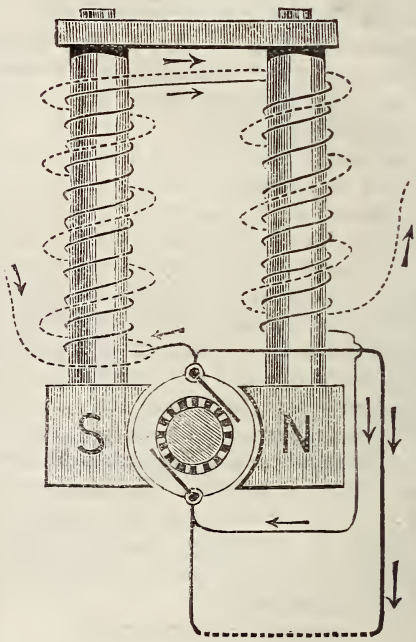
This arrangement, which is depicted in

FIG. 20.



COMBINATION OF SERIES AND SEPARATE.

FIG. 21.



SHUNT AND SEPARATE.

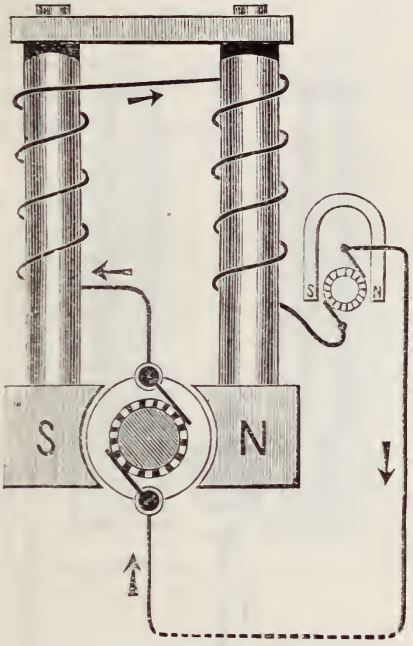
* Professor Perry gives, in his specification, the following numerical illustration, to which the only exception that can be taken is, that with so high a resistance as that of three ohms in the machine the system must be very uneconomical. "As an example, if there s only one dynamo machine, and if the resistance of the main cable, return cable and machines, in fact, of that part of the total circuit which is supposed to be constant, be, let us suppose, three ohms, then we find that the dynamo machine ought to be run at such a speed that the electromotive force, in volts, produced in its moving parts is three times the current in ampères, which flows through the field-magnets, consequently this speed can readily be found by experiment. Suppose the constant electromotive force of the magneto machine to be 50 volts; its resistance 0·3 ohms, and the resistance of the dynamo machine and of the other unchanging parts of the circuit 2·7 ohms; and suppose that the speed is that at which the electromotive force produced by the rotating armature of the

Fig. 22, may be varied by using a shunt-wound dynamo, the magnets being, as before, included in the part of the circuit outside the machines. The combination of a permanent magnet with electro-magnets in one and the same machine, is much older than the suggestions of either Deprez or Perry, having been described by Hjörth in 1854.

(4.) *Shunt and Magneto (Constant Current), Perry.*—Perry's arrangement for constant current is given in diagram in Fig. 23, and consists in combining a shunt-dynamo with a magneto machine of independent electro-motive force, this magneto machine being inserted either in the armature part or in the magneto-shunt coils of the machine. As before, a certain critical speed must be found from experiment and calculation.

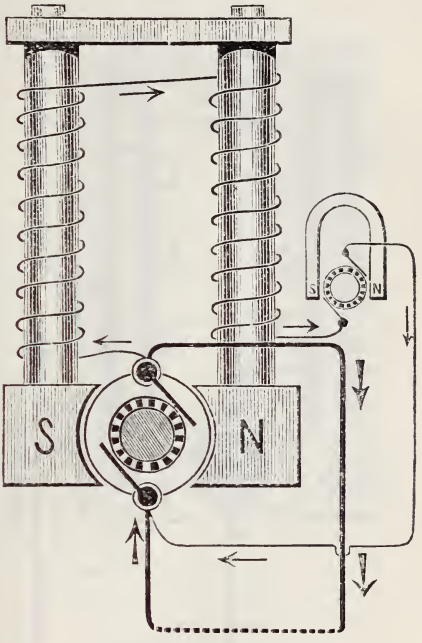
(3.) *Series and Shunt.*—A dynamo having its coils wound, as in Fig. 24 (p. 140), so that the field-magnets are excited partly by the main current, partly by a current shunted across the brushes of the machine, is no novelty, having been used in Brush dynamos* for some years past. The arrangement is not so perfect as either of the preceding, being more

Fig. 22.



Series and Magneto.

Fig. 23.



Shunt and Magneto.

limited in operation. If the shunt coils be comparatively few, and of high resistance, so that their magnetising power is small, the machine will give approximately a uniform electromotive force; whereas, if the shunt be relatively a powerful magnetiser, as compared with the few coils of the main circuit, the machine will be better adapted for giving a constant current; but, as before, each case

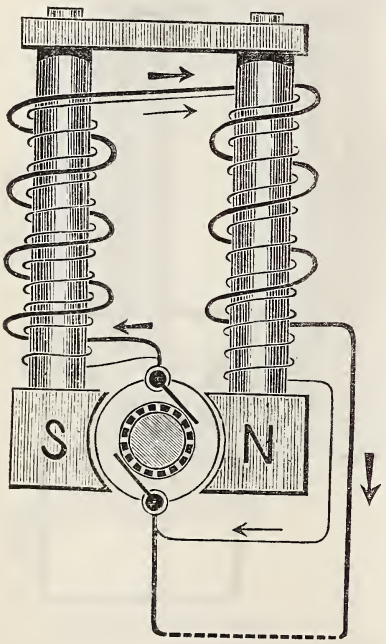
dynamo is three times the current. Now, let there be a consumer's resistance of 2 ohms, the total resistance is 5 ohms. Evidently the electromotive force produced in the dynamo is 75 volts (for call this electromotive force x, then the current will be $x \div 3$ whence it follows that $\frac{x+50}{5} = \frac{x}{3}$ or $3x + 150 = 5x$, or $x = 75$) and the total electromotive force in the circuit is, therefore, 125 volts, and, as the total resistance is 5 ohms, the current is 25 ampères, giving an electromotive force of 50 volts between the ends of the consumers' part of the circuit. Now, if the consumers' resistance increases to, say, 12 ohms, by some of the consumers ceasing to use their circuits, there is an instantaneous alteration of the electromotive force produced in the dynamo to 12½ volts, or 62½ volts in the whole circuit, and 62½ divided by 15 gives 4⅙ ampères; and this means 4⅙ multiplied by 12 or 50 volts as before, between the ends of the consumers' part of the circuit. (Here, again, the calculation is:— $\frac{x+50}{15} \quad \frac{x}{3}$, whence $3x + 150 = 15x$, or $12\frac{1}{2} = x$. (S.P.T.)

* The shunt part of the circuit, originally called the "teazer," was adopted at first in machines for electro-plating, with the view of preventing a reversal of the current by an inversion of the magnetisation of the field-magnets, but has been retained in some other patterns of machine on account of its usefulness in "steadying" the current. I am informed that Messrs. Siemens and Halske have also used this combination for some time past.

will correspond to a certain critical speed, depending on the arrangements of the machine.

(6.) *Series and Long Shunt.*—I propose to give this name to a combination closely resembling the preceding, which has not yet, so far as I am aware, been actually tried. If, as in Fig. 25, the magnets are excited partly in series, but also partly by coils of finer wire, connected as a shunt *across the whole external circuit*, then the combination should be more applicable than the preceding to the case of a constant electromotive force, since any variation in the resistance of the external circuit will produce a greater effect in the "long shunt" than would be produced if the resistance of the field-magnets were included in the part of the main circuit external to the shunt.

Fig. 24.

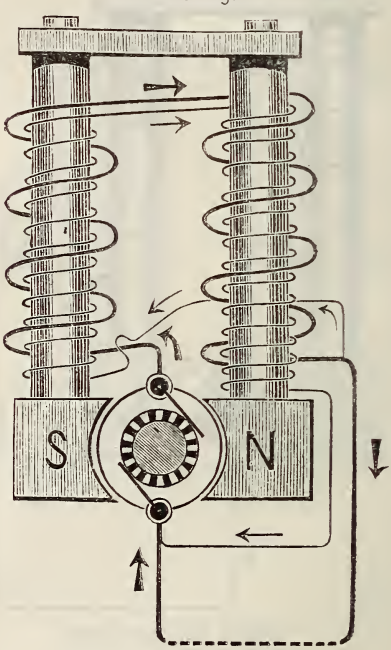


Series and Shunt.

Although the last two combinations are not such perfect solutions of the problem as those which precede, they are more likely, in my opinion, to find an immediate application,* since they can be put into practice upon any ordinary machine, and do not require, as in the first four combinations, the use of separate exciters, or of independent magneto-machines.

All these arrangements presuppose a constant velocity of driving; but they are not the only ones consistent with this condition. An ordinary series dynamo may be made to yield a constant current, by introducing across the field-magnets a shunt of variable resistance, the resistance of the shunt being adjusted automatically by an electro-magnet, whose coils form part of the circuit. This is actually done in the automatic regulator attached to Brush dynamos, as used in supplying a series of arc lights. A shunt-dynamo may similarly be controlled, so as to yield a uniform electromotive force, by introducing a variable resistance into the shunt-magnet circuit, as is done in some of Edison's dynamos. To make the arrangement perfect, this variable resistance should be automatically adjusted by an electro-magnet whose coils are an independent shunt across the mains of the external circuit.

Fig. 25.



Series and Long-Shunt.

Yet another way of accomplishing the regulation of dynamos is possible in practice, and this without the condition of a constant speed of driving. Let the ordinary centrifugal governor of the steam-engine be abandoned, and let the supply of steam be regulated, not by the condition of the velocity of driving, but

* Since the above was written, an account of a similar combination to the 5th mentioned above has appeared in the pages of the *Electrician*, under the name of Crompton's Compound Dynamo. Mr. R. M. Bosanquet, of St. John's College, Oxford, has also suggested a similar arrangement for charging accumulators with a constant electromotive force.

by means of an electric governor, such as an electro-magnet working against an opposing spring. If this electro-magnetic governor is to maintain a constant electromotive force, its coils must be a shunt to the mains of the circuit. If it is to maintain a constant current, its coils must be part of the main circuit. Such a governor ought to be more reliable and rapid than any centrifugal governor intended to secure a uniform speed of driving.

Organs of Dynamos.

I now propose to return to some of the rules and suggestions which we arrived at a week ago, in considering the dynamo in theory, and see how they are borne out in the dynamo as constructed in practice. I shall try to illustrate the various points that come under review, as far as possible, from the more recent types of dynamo.

Field-Magnets.

In the classification of dynamos, laid down in my first lecture, we found that those of the first class required a single approximately uniform field of force, whilst those of the second class required a complex field of force differing in intensity and sign at different parts. Accordingly, we find a corresponding general demarcation between the field-magnets in the two classes of machine. In the first, we have usually two pole-pieces on opposite sides of a rotating armature. In the second, a couple of series of poles set alternately round a circumference or crown, the coils which rotate being set upon a frame between two such crowns of poles.

Confining ourselves, at first, to the first class of machines, we find that, in practice, their magnets differ widely in construction and design. In very few of the existing patterns is there much trouble taken to secure steady magnets, by making them long, heavy, and solid, or with very heavy pole-pieces. I have repeatedly, in testing dynamos, had to report that an unnecessary amount of wire had been wound upon the field-magnets; and I find that the usual reply is that, with less wire, the machine does not work so well. If, however, it is found necessary to wind on so many coils upon the magnets as to bring these practically to saturation long before the machine is doing its maximum work, it is clear that either the iron is insufficient in quantity, or it is deficient in quality. In the Bürgin machines, where cast-iron field-magnets are employed, the smaller magnetic susceptibility of this metal is made up for by employing a great weight of it. In Siemens's smaller dynamos, the amount of iron employed in the field-magnets would be quite insufficient if it were not of high quality. As it is, I am of opinion, the mass of it (especially in the polar parts) might, with advantage, be increased. In some of the early machines of Wilde, and in Edison's well-known dynamos, long field-magnets, with heavy pole-pieces, are found. Edison's dynamos, indeed, are all remarkable in this feature; the pole-pieces and the yoke connecting the iron cores of the coils are made abnormally heavy. This is not more noticeable in the giant dynamos, used at the Holborn-viaduct (see Fig. 30, p. 145), than in the smaller machines used in isolated installations for sixty and for fifteen lights.

The principle of shaping the magnets, so that their external form approximates to that of the magnetic curves of the lines of force, is to some extent carried out in such widely differing types of machine as the Gramme with "Jamin" magnet, the Jürgensen dynamo, and Thomson's "mousemill" dynamo. The two machines last named exhibit several curious contrasts. In the Jürgensen, the field-magnets have heavy pole pieces; in the Thomson there are none; and in the Thomson machine the iron core is thicker at the middle than at the ends. In both there are auxiliary internal electro-magnets, fixed within the rotating armature, to concentrate and augment the intensity of the field, according to the device patented by Lord Elphinstone and Mr. Vincent. In the Thomson machine the coils are heaped on more thickly at the middle of the field-magnets; in the Jürgensen, the coils are crowded up around the poles. The latter arrangement I condemned from the point of view of theory last week. If we may judge from a report on this machine by Professors Ayrton and Perry,* the arrangement is not satisfactory in practice, as there are more coils than suffice to magnetise the magnets. Is it possible that the mistake is not in having too many coils, but in having them in the wrong place?

Another suggestion, which was indicated from theoretical considerations, was that of laminating the pole-pieces, so as to prevent the production in them of wasteful Foucault currents. Here I find that but one machine has been designed in which this precaution is carried into effect. This is the disk-dynamo

* See *Electrical Review*, Sept. 23, 1882.

of Drs. Hopkinson and Muirhead, the field-magnets of which are made up of laminæ of iron, cast into a solid iron backing.

Another matter in which, up to the present time at least, there is nothing but empirical practice to guide us, is the form to be given to pole-pieces, in order to produce the best effect. In fact, we have such singular divergence in practice, as to suggest the thought that little importance has been attached to the matter. Yet upon the form and extent given to the pole-pieces, depend considerations of no less importance than the reduction of idle wire in the armature, the reduction of sparking at the commutator, and the avoidance of counter-electromotive forces in the armature. If the pole-pieces are badly shaped for their work, or approach one another too far round the armature, they may completely perturb the approximate uniformity of the field, and may cause the central portion of the field to be of much weaker intensity than the two lateral regions between the edges of the pole-pieces. When this is the case, the rotating coils are virtually moving in a double field, and it is even possible that, in consequence, the direction of the currents induced in the individual coils may be reversed four or six times as they make one rotation. In such a case the distribution of potential round the separate bars of the commutator will be abnormal, as we shall see later on.

Armatures.

The armatures of dynamos of the first class may be roughly classified in three groups, according to the manner of arranging the coils. These three groups are—

(1.) *Ring armatures*, in which the coils are grouped upon a ring, whose principal axis of symmetry is its axis of rotation also.

(2.) *Drum armatures*, in which the coils are wound longitudinally over the surface of a drum or cylinder.

(3) *Pole armatures*, having coils wound on separate poles, projecting radially all round the periphery of a disc or central hub.

(To these we shall add a fourth form, namely, that of *Disk armatures*, when we deal with dynamos of the second class.)

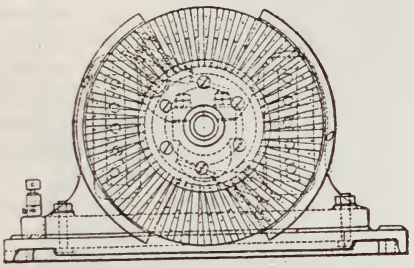
The object of all these combinations is to obtain the practical continuity of current spoken of in section *t* of the first lecture. Some of the individual coils should be moving through the position of maximum action, whilst others are passing the neutral point, and are temporarily idle. Hence a symmetrical arrangement around an axis is needed. Ring-armatures are adopted in practice in the dynamos of Pacinotti, Gramme, Schückert, Gülcher, Fein, Heinrichs, De Meritens, Brush, Jürgensen, and others. Drum armatures are found in the Siemens (Alteneck), Edison, Elphinstone-Vincent, Laing, and other machines. Pole-armatures are used in the dynamos of Allen and of Lontin. There are several intermediate forms. The Bürgin armature consists of eight or ten rings, side by side, so as to form a drum. The Lontin (continuous-current dynamo) has the radial poles affixed upon the surface of a cylinder. The Maxim armature is a hollow drum wound like a Gramme ring, and has therefore a great quantity of idle wire on the inner surface of the drum. The Weston armature has the drum surface cut up into longitudinal poles; there is a similar armature by Jablochkoff, in which the poles are oblique.

Ring armatures are found in many machines, but the ingenuity of inventors has been exercised chiefly in three directions:—The securing of practical continuity; the avoidance of Foucault currents in the cores; and the reduction of useless resistance. In the greater part of these machines, the coils that form the sections of the ring are connected in series, the end of one to the beginning of the next, so that there is a continuous circuit all round, an attachment being made between each pair to a bar or segment of the collector. Most inventors have been content to secure approximate continuity by making the number of sections numerous. One inventor, Professor Perry, has built up a ring with coils wound obliquely, so that the one coil reaches the neutral point before the preceding one has passed it. I cannot help doubting the advantage of this arrangement; which, moreover, presents mechanical difficulties in construction. Pacinotti's early dynamo had the coils wound between projecting teeth upon an iron ring. Gramme rejected these cogs, preferring that the coils should be wound round the entire surface of the endless core. To prevent wasteful currents in the cores, Gramme employed for that portion a coil of varnished iron wire of many turns. In Gülcher's latest dynamo, the ring-core is made up of thin flat rings cut out of sheet iron, furnished with projecting cogs, and laid upon one another. The parts of the coils which pass through the interior of the ring (in spite of the late M. Antoine Breguet's ingenious proof that some of the lines of force of the field bent round and turned back into the core in this interior region) are comparatively idle. They cut very few lines

of force as they rotate, and therefore offer a wasteful resistance. Inventors have essayed to reduce this source of loss, by either fitting projecting flanges to the pole pieces (as in Fein's dynamo) or by using internal magnets (as in Jürgensen's dynamo), or else by flattening the ring into a disk-form, so as to reduce the interior parts of the ring-coils into an insignificant amount. This is done in the dynamos of Schückert and of Gülcher. In Fig. 26 is given the latest form of Gülcher's dynamo. The field-magnets, front and back of the ring, are united on the right and left sides in a pair of hollow pole pieces, which form cases over the ring, covering a considerable part of it. The collector is identical with that of Gramme, but very substantial.

The drum-armatures may all be regarded as modifications of Siemens's well-known longitudinal shuttle-form armature of 1856, the

Fig. 26.

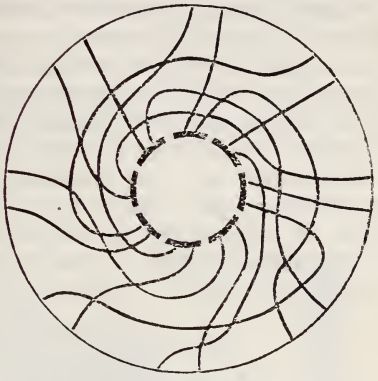


Gulcher's Dynamo (new pattern).

multiplicity of sections of the coils affording practical continuity in the currents. In some of Siemens's machines the cores are of wood, overspun with iron wire circumferentially, before receiving the longitudinal windings. In another of their machines there is a stationary iron core, outside which the hollow drum revolves; in other machines, again, there is no iron in the armature beyond the driving-spindle. In all of the Siemens armatures the individual coils occupy a diametral position with respect to the cylindrical core, but the mode of connecting up the separate diametral sections is not the same in all. In the older of the Alteneck-Siemens windings the sections were not connected together symmetrically, the connexions (for an eight-part collector) being as in Fig. 27. But in the more recent machines a symmetrical plan has been adhered to, as shown in Fig. 28.

In this system, as in the Gramme ring, the successive sections of coils ranged round the armature are connected together continuously, the end of one section, and the beginning of the next, being both united to one segment or bar of the collector. A symmetrical arrangement is, of course, preferable, not only for ease of construction, but because it is important that there should never be any great difference

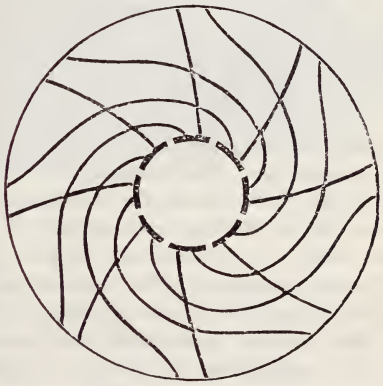
Fig. 27.



Alteneck-Siemens Winding (old).

of potential between one segment of the collector and its next neighbour; otherwise there will be increased liability to spark, and form arcs across the intervening gap. In Edison's modification of the drum-armature, the winding, though symmetrical in one sense, is singular, inasmuch as the number of sections

Fig. 28.

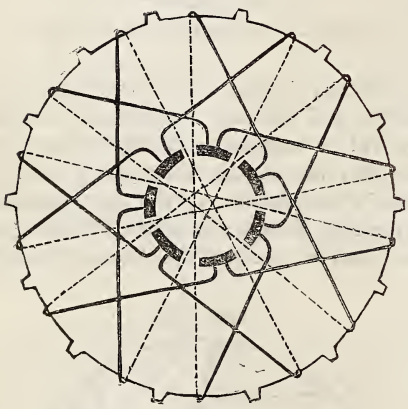


Alteneck-Siemens Winding (new).

is an odd number. In the first machines there were seven paths, as shown in Fig. 29 (p. 144), taken from Edison's Patent Specification. In his latest giant machines, the number of sections is forty-nine. One consequence of this peculiarity of structure is that, if the brushes are set diametrically opposite to one another,

they will not pass at the same instant from section to section of the collector; one of them will be short-circuiting one of the sections, whilst the other is at the middle of the opposite collector. The armature of these latest of Edison's dynamos (Fig. 30,* p. 145) is not wound up with wire, but, like some of Siemens's electro-plating dynamos, is constructed of solid bars of copper, arranged around the periphery of a drum. The ends are connected across by washers or disks of copper, insulated from each other, and having projecting lugs, to which the copper bars are attached. Such disks present much less resistance than mere strips would do. The connexions are in the following order:—Each of the forty-nine bars of the collector is connected to one of the forty-nine disks at the anterior end of the drum, which is connected, by a

FIG. 29.



EDISON'S WINDING.

lug-piece on one side, to one of the ninety-eight copper bars. The current generated in this bar runs to the further end of the machine, enters a disk at that end, crosses the disk, and returns along a bar diametrically opposite that along which it started. The anterior end of this bar is attached to a lug-piece of the next disk to that from which we began to trace the connections, it crosses this disk to the bar next but one to that first considered, and so round again. The two lug-pieces of the individual disks at the anterior end are, therefore, not exactly opposite each other, diametrically, as the connections advance through $\frac{1}{49}$ of the circumference at each of the 49 paths. It will be noticed in Fig. 30* that the collector is very substantially built, and that a screen is fixed between the collector and the rest of the armature, to prevent any copper-dust from flying back or clogging the insulation between the bars or disks. There are no fewer than five pairs of brushes, the tendency to sparking being thereby greatly reduced. The figure does not show the structure of the armature itself, nor indicate the means taken to suppress Foucault currents. The core of the armature is made of very thin disks of iron,* separated, by mica or asbestos paper, from each other, and clamped together. Some exception may be taken to the use of such stout copper bars, as being more likely to heat from local currents than would be the case if bundles of straps, or laminæ of copper were substituted. And, indeed, the presence of the 4-horse power fan to cool the armature, is suggestive that continuous running is liable to heat the armature.

Before passing on from the subject of armatures, it is worth while to mention the peculiarity of form of the Bürgin armature, which has already been spoken of as consisting of eight, or in the newest Bürgin machines, as constructed by Mr. R. E. Crompton, of ten rings, set side by side.† Each ring is made of a hexagonal coil of iron wire, mounted upon light metal spokes, which meet the corners of the hexagon. Over this hexagonal frame, six coils of covered copper wire are wound, being thickest at the six points intermediate between the spokes, thus making up the form of each ring to nearly a circle. Each of the six coils is separated from its neighbour, and each of the ten rings is fixed to the axis $\frac{1}{60}$ of the circumference in advance of its neighbour, so that the 60 separate coils are in fact arranged equidistantly (and symmetrically, as viewed from the end) around the axis. There is a 60-part collector, each bar of which is connected to the end of one coil and to the beginning of the coil that is one-sixtieth in advance; that is, to the corresponding coil of the next ring. This armature has the great practical advantages of being easy in construction, light, and with plenty of ventilation.

In the Elphinstone-Vincent dynamo there is a drum-armature of a somewhat distinct order, the separate coils being made of a rectangular form, and then laid upon the sides of a hollow papier-maché drum in an overlapping manner, and curved to fit it. The field is a com-

* Taken, by permission of Messrs. Macmillan & Co., from my "Elementary Lessons in Electricity and Magnetism."

* Disks of thin iron for a similar purpose are found in the dynamos of Jablochkoff, Weston, and Gülcher.

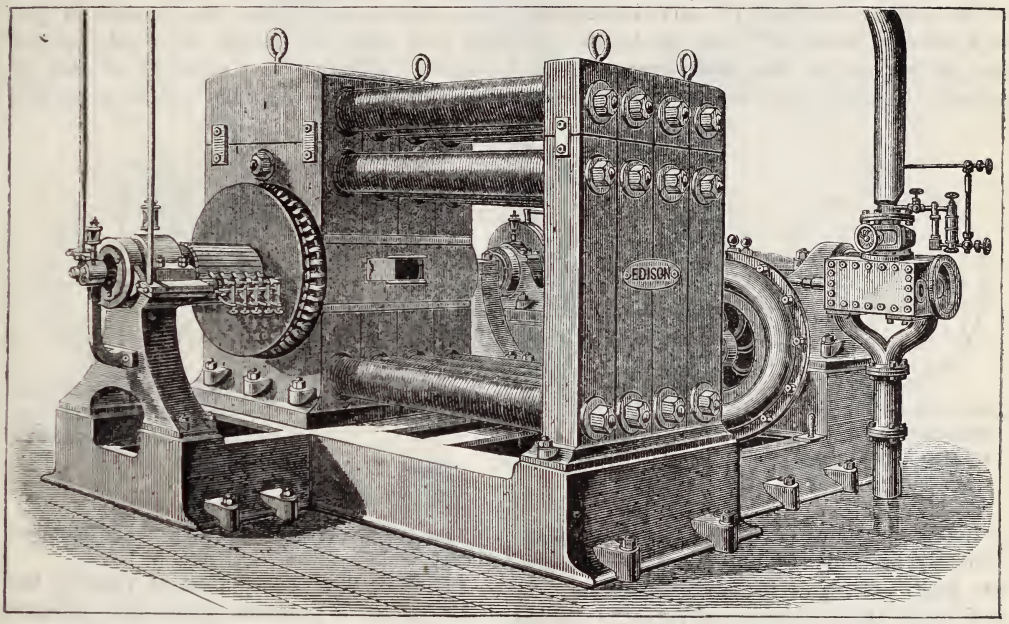
† The *Bürgin* armature exhibited, was kindly lent by Messrs. R. E. Crompton and Co.

plex one, with six external and six internal poles, and is very intense, owing to the proximity of these poles. The parallelogram-shaped coils are connected together so as to work as three machines, and feed three pairs of brushes; which may again be united, either in series or in parallel, or may be used to feed three separate circuits.

Collectors.

In section *ab* of the first lecture, the main points to be observed in the construction of collectors are enumerated. Collectors of substantially such type as there described are common all dynamos of the first class, except only the Brush dynamo, in which there is a multiple commutator, instead of a collector. The collector of Pacinotti's early machine differed only in having the separate bars alternately a little displaced longitudinally along the cylinder, but still so that the same brush could slip from bar to bar. Niaudet's modification, in which the bars are radially attached to a disk, is a mere variety in detail, and is not justified by successful adoption. In the collector, as used in Weston's dynamo, and in some forms of Schuckert's dynamo, the bars are oblique or curved, without, however, any

Fig. 30.



Edison's Steam-dynamo.

to other effect than that of prolonging the moment during which the brush, while slipping from contact with one bar to contact with the next, short-circuits one section of the coil.

In a well-arranged dynamo of the first class, the sections of the collector are traversed by currents, which run from the negative brush in two directions round the successive coils, and meet at that bar of the collector which touches the positive brush. Each section of the coil thus traversed adds its own electromotive force to the current passing through it. Consequently, if one measures the difference of potential between the negative brush and the successive bars of the collector, one finds that the potential increases regularly all the way round the collecting cylinder, in both directions, becoming a maximum at the opposite side where the positive brush is. This can be verified by connecting one terminal of a voltmeter to the negative brush, and touching the rotating collector at different points of its circumference with a small metallic brush or spring attached by a wire to the other terminal of the voltmeter. If the indications thus obtained are plotted out round a circle corresponding to the circumference of the collector, the values give a curve

like that shown in Fig 31, which is plotted out from observations taken upon a Gramme dynamo.*

In can be seen that, taking the negative brush as the lowest point of the circle, the potential rises perfectly regularly to a maximum at the positive brush. The same values are also plotted out as ordinates upon a horizontal line in Fig. 32. This form of diagram shows very clearly that the rise of potential is not equal between each pair of bars, otherwise the curve would consist merely of two oblique straight lines, sloping right and left from the central point. On the contrary, there is very little difference of potential between the collector bars close to the + brush on its right and left respectively. The greatest difference of potential occurs where the curve is steepest, at a position nearly 90° from the brushes, in fact, at that part of the circumference of the collector which is in connection with the coils that are passing through the position of best action. Were the field perfectly uniform, the number of lines of force that pass through a coil ought to be proportional to the sine of the angle which the plane of that coil makes with the resultant direction of the lines of force in the field, and the rate of cutting the lines of force should be proportional to the cosine of this angle. Now the cosine is a maximum when this angle = 0°; hence, when the coil is parallel to the lines of force, or at 90° from the brushes, the increase of potential should be at its greatest—as is very nearly realised in the diagram of Fig. 32, which, indeed, is very nearly a true "sinusoidal" curve. Such curves, plotted out from measurements of the distribution of potential at the collector, show not only where to place the brushes to get the best effect, but enable us to judge of the relative "idleness" or "activity" of coils in different parts of the field, and to gauge the

Fig. 31.

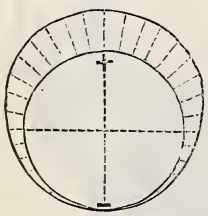
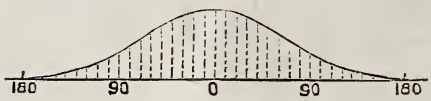


Diagram of Potential round the Collector of Gramme Dynamo.

Fig. 32.



Horizontal Diagram of Potentials at Collector of Gramme Dynamo.

Fig. 33.

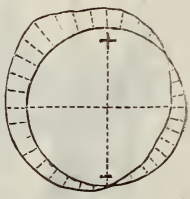
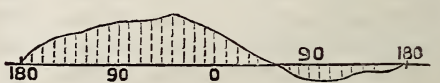


Diagram of Potential round the Collector of a Badly-arranged Dynamo.

actual intensity of different parts of the field while the machine is running. If the brushes are badly set, or if the pole-pieces are not judiciously shaped, the rise of potential will be irregular, and there will be maxima and minima of potential at other points. An actual diagram, taken from a dynamo in which these arrangements were faulty, is shown in Fig. 33, and again is plotted horizontally in Fig. 34; from which it will be seen, not only that the rise of potential was irregular, but that one part of the collector was more positive than the positive brush, and another part more negative than the negative. The brushes, therefore, were not getting their proper difference of potential; and, in part of the coils, the currents were actually being forced against an opposing electromotive force.

I believe that this method of plotting the distribution of potential round the collector will prove very useful in practice, and will explain various puzzling and anomalous results found by experimenters who have not

Fig. 34.



Horizontal Diagram of Potentials at Collector of Faulty Dynamo.

known how to explain them. In a badly-arranged dynamo, such as that giving such a diagram as Fig. 33, a second pair of brushes, applied at the points shewing maximum and minimum potential, could draw a good current without interfering greatly with the current

* This diagram was plotted for me, and the measurements made at my request, by Mr. W. M. Mordey, who first drew my attention to some of the abnormal phenomena mentioned later.

flowing through the existing brushes! In fact, I find that this bad distribution, giving rise to anomalous maxima and minima, has actually been patented by a gentleman of the name of Kennedy,* who puts brushes on *six* different points of a collector!

Curves, similar to those given, can be obtained from the collectors of any dynamo of the first class—Gramme, Siemens, Edison, &c.—saving only from the Brush machine, which, having no such collector, gives diagrams of quite a different kind. It is, of course, not needful in taking such diagrams that the actual brushes of the machine should be in contact, or that there should be any circuit between them, though in such cases the field-magnets must be separately excited. It should also be remembered that the presence of brushes, drawing a current at any point of the collector, will alter the distribution of

FIG. 35.

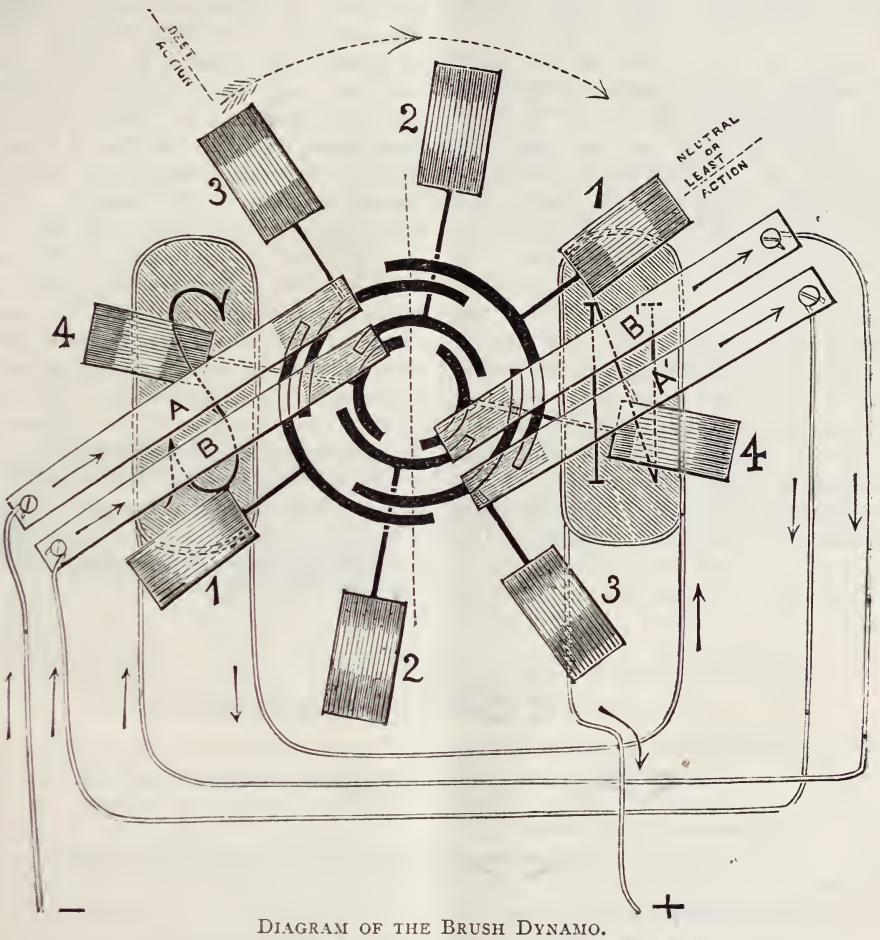


DIAGRAM OF THE BRUSH DYNAMO.

potential in the collector; and the manner and amount of such alteration will depend on the position of the brushes, and the resistance of the circuit between them.

THE BRUSH DYNAMO.

Before passing on to the dynamos of the second class, I have some remarks to make on that much mis-understood and mis-described machine, the Brush dynamo. Its armature—a ring in form, not entirely overwound with coils, but having projecting teeth between the coils like the Pacinotti ring — is unique. Though it thus resembles Pacinotti's ring, it differs more from the Pacinotti armature than that armature differs from those of Siemens, Gramme, Edison, Bürgin, &c.; for in all those the successive sections are united in series all the way round, and constitute, in

* British Patent, No. 1,640 (1882).

one sense, one continuous bobbin. But in the Brush armature there is no such continuity. The coils are connected in pairs, each to that diametrically opposite it, and carefully isolated from those adjacent to them. For each pair of coils there is a separate commutator, so that, for the ordinary ring of eight coils, there are four distinct commutators side by side upon the axis—one for each pair of coils. The brushes are arranged so as to touch at the same time the commutators of two pairs of coils, but never of two adjacent pairs; the adjacent commutators being always connected to two pairs of coils that lie at right angles to one another in the ring. The arrangement is best studied graphically from the diagram given in Fig. 35 * (p. 147). In this figure, the eight coils are numbered as four pairs, and each pair has its own commutator, to which pass the outer ends of the wire of each coil, the inner ends of the two coils being united across to each other (not shown in the diagram). In the actual machine, each pair of coils, as it passes through the position of least action (*i.e.*, when its plane is at right angles to the direction of the lines of force in the field, and when the number of lines of force passing through it is a *maximum*, and the rate of change of these lines of force a *minimum*) is cut out of connexion. This is accomplished by causing the two halves of the commutator to be separated from one another by about one-eighth of the circumference at each side. In the figure it will be seen that the coils marked 1_1 1_1 are "cut out." Neither of the two halves of the commutator touches the brushes. In this position, however, the coils 3_1 3_1, at right angles to 1_1 1_1, are in the position of best action, and the current powerfully induced in them flows out of the brush marked A, (which is, therefore, the negative brush) into that marked A′. This brush is connected across to the brush marked B, where the current re-enters the armature. Now, the coils 2, 2, have just left the position of best action, and the coils, 4, 4, are beginning to approach that position. Through both these pairs of coils, therefore, there will be a partial induction going on. Accordingly, it is arranged that the current, on passing into B, splits, part going through coils 2, 2, and part through 4, 4, and re-uniting at the brush B′, whence the current flows round the coils of the field-magnets to excite them, and then round the external circuit, and back to the brush A. (In some machines it is arranged that the current shall go round the field-magnets after leaving brush A′, and before entering brush B; in which case the action of the machine is sometimes, though not correctly, described as causing its coils, as they rotate, to feed the field-magnets and the external circuit alternately). The rotation of the armature will then bring coil 2, 2, into the position of least action, when they will be cut out, and the same action is renewed with only a slight change in the order of operation. The following table summarises the successive order of connexions during a half-revolution:—

First position. (Coils 1 cut out.)

A — 3 — A; B $\lessgtr^{4}_{2}$ B; Field-magnets — External circuit — A.

Second position. (Coils 2 cut out.)

A $\lessgtr^{1}_{3}$ A; B — 4 — B; Field-magnets — External circuit — A.

Third position. (Coils 3 cut out.)

A — 1 — A; B $\lessgtr^{2}_{4}$ B; Field-magnets — External circuit — A.

Fourth position. (Coils 4 cut out.)

A $\lessgtr^{3}_{1}$ A; B — 2 — B; Field-magnets — External circuits —A.

From this it will be seen that whichever pair of coils is in the position of best action, is delivering its current direct into the circuit; whilst the two pairs of coils which occupy the secondary positions are always joined in parallel, the same pair of brushes touching the respective commutators of both.

One consequence of the peculiar arrangement thus adopted is, that measuring the potentials round one of the commutators with a voltmeter gives a wholly different result from that obtained with other machines. For one-eighth of the circumference on either side

* This diagram I have constructed somewhat on the lines of a working model kindly lent me by Mr. Percy Allen, of the Anglo-American Corporation; which, however, was designed to show the action of larger dynamo, having twelve coils on the ring and six commutators.

of the positive brush, there is no sensible difference of potential. There then comes a region in which the potential appears to fall off; but the falling off is here partly due to the shorter time during which the adjustable brush connected with the voltmeter and the fixed positive brush are both in contact with the same part of the commutator. Further on there is a region in which the voltmeter gives no indications corresponding to the cut out position; and again, on each side of the negative brush, there is a region where the polarity is the same as that of the negative brush. Fig. 36 is a diagram of a 6-light Brush taken at one commutator, the main + brush being, however, allowed to rest (as in its usual position),

Fig. 36.



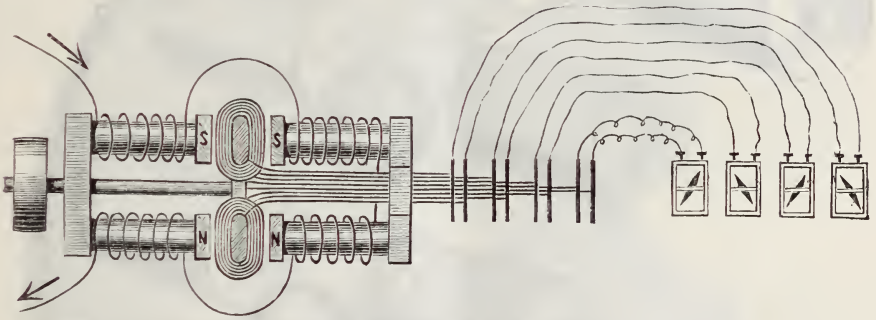
Diagram of Potentials at Commutator of Brush Dynamo.

in contact with both this commutator and the adjacent one.

From the foregoing considerations, it will be clear that the four pairs of coils of the Brush machine really constitute four separate machines, each delivering alternate currents to a commutator, which commutes them to intermittent uni-directional currents in the brushes; and that these independent machines are ingeniously united in pairs by the device of letting one pair of brushes press against the commutators of two pairs of coils. Further, that these paired machines are then connected in series, by bringing a connection round from brush A′ to brush B.

The following experiment illustrates the independence of the four pairs of coils in the Brush dynamo.* The usual commutators of a small Brush dynamo were removed and replaced by eight brass collars, to each of which was united one end of one of the four pairs of coils. Against these rings pressed eight

Fig. 37.



Brush Dynamo arranged with 4 Detector Galvanometers showing alternate current induced in independent pairs by coils.

separate brushes, and the circuit of each of the four pairs of coils was completed, as shewn in Fig. 37, through an ordinary detector galvanometer. On rotating the armature by hand, at a moderate speed, the needles of all four detectors are set vibrating to and fro by the alternate currents, not synchronously, but one after the other. If any one of the four circuits are broken, the others go on as before.

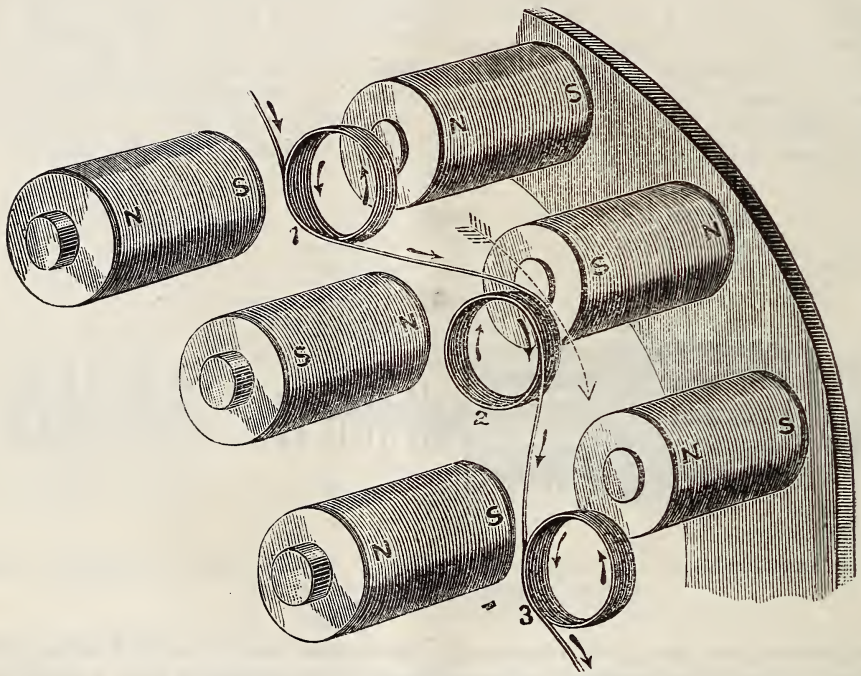
Dynamos of the Second Class.

I now pass on to dynamos of the second class, in which coils are carried round to different parts of a magnetic field, whose intensity differs in different regions, or one, in different parts of which the lines of force run in opposite directions. Fig. 13 of my first lecture illustrated this principle; and we shall now consider how it is carried out in practice. In the early machine of Pixii a single pair of coils was mounted so as to pass in this fashion through parts of the field where the magnetic induction was oppositely directed. Such a machine, therefore, gives alternate currents, unless a commutator be affixed to the rotating axis. Niaudet's dynamo, which may be regarded as a compound Pixii machine, having the separate armature coils united as those of Gramme and Siemens into one continuous circuit, is furnished with the radial collector mentioned above. In the Wallace-Farmer dynamo is very nearly realised the condition of field of Fig. 13, there being a pair of

* This beautiful experiment was first shown me by Mr. P. Allen, who kindly fitted up the little Brush dynamo with the eight collars for this occasion.

poles at the top arranged so that the north faces the south pole, and another pair at the bottom where the south faces the north pole. The coils are carried round, their axis being always parallel to the axis of rotation, upon a disk; there being two sets of coils on opposite faces of two disks of iron set back to back. They are united precisely as in Niaudet's dynamo, and each disk has its own collector. Each bar of the collector is, moreover, connected, as in the dynamos of Pacinotti, Gramme, Siemens, &c., with the end of one coil, and the beginning of the next. In fact, the Wallace-Farmer machine is merely a double Niaudet dynamo with cylindrical collectors. There is a serious objection to the employment of solid iron disks such as these. In a very short time they grow hot from the eddying Foucault currents engendered in them as they rotate. This waste reduces the efficiency of the dynamo. In the dynamo of Hopkinson and Muirhead, the disk-armature takes a more reasonable shape. Instead of a solid disk of iron to support the coils, there is a disk built up of a thin iron strip wound spirally round a wooden centre. The coils, of approximately quadrangular shape, and flat form, are wound

Fig. 38.



Principle of Alternate-current Dynamos.

upon the sides of this compound disk. The dynamo of Ball (the so-called "Arago-disk" machine) is similar in many respects, but has no iron cores to the armature coils.

Alternate-current Dynamos.

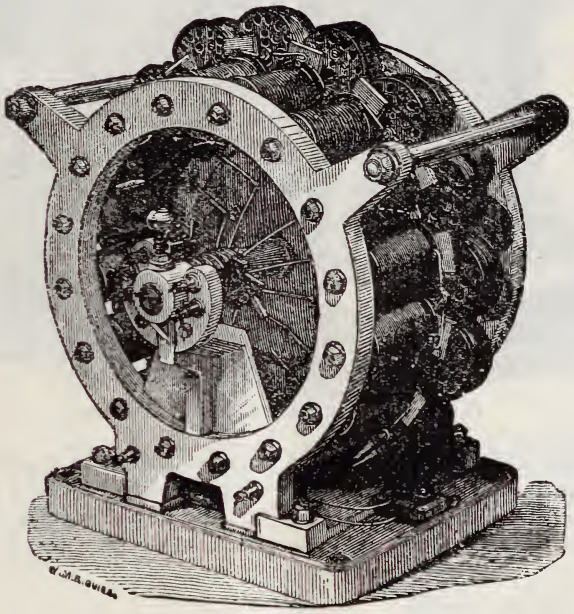
But by far the most important of the dynamos of this second class are those usually known as *alternate-current machines*. This type of dynamo was originally created by Wilde, in 1867. The field-magnets consist of two crowns of fixed coils, with iron cores, arranged so that their free poles are opposite to one another, with a space between them sufficiently wide to admit the armature. The poles taken in order round each crown are alternately of north and south polarity, and opposite a north pole of one crown faces a south pole of the other crown. This description will apply to the magnets of the alternate current machines of Wilde and Siemens, to the so-called Ferranti machine, and, with certain reservations, to the machines of Lachaussée and of Gordon. The armatures in almost all machines of this type consists of a *disk*, bearing at its periphery a number of coils, whose axes are parallel to the axis of rotation. The principle will be best understood by reference to Fig. 38, which

gives a general view of the arrangement. Since the lines of force run in opposite directions between the fixed coils, which are alternately S—N, N—S, as described above, the moving coils will necessarily be traversed by alternating currents; and as the alternate coils of the armature will be traversed by currents in opposite senses, it is needful to connect them up, as shown in the figure, so that they shall not oppose one another's action.

In Wilde's dynamo, the armature coils have iron cores, and the machine is provided with a commutator on the same principle as that used by Jacobi in his famous motor of 1838, consisting of two metal cylinders, cut like crown wheels, having the teeth of one projecting between those of the other, so that the brushes make contact against them alternately as they rotate. The brushes are, of course, fixed, so that they do not both touch the same part. This commutator Wilde usually applied to a few, or only one, of the rotating coils, and utilised the current thus obtained to magnetise the field-magnets. The main current was not so commuted, but was led away from a simple collector, consisting of two rings connected to the two ends of the armature circuit, each being pressed by one brush.

Siemens prefers to use a separate direct

Fig. 39.



Siemens's Alternate-current Dynamo.

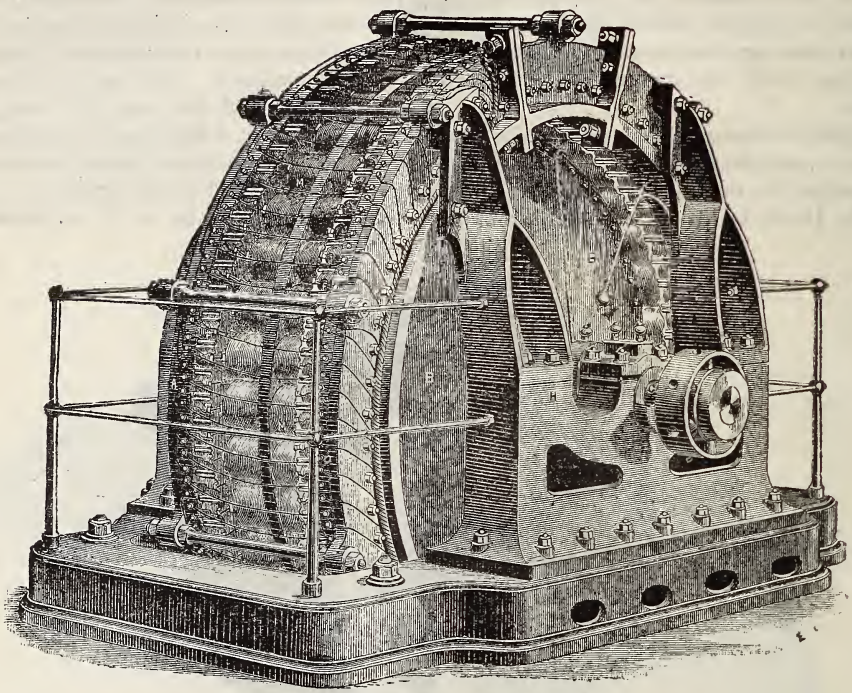
of current machine to excite the field-magnets of alternate-current dynamo. In the armature of the latter (see Fig. 39), the coils are wound usually without iron, upon wooden cores. In some forms of the machine, the individual coils are enclosed between perforated disks of thin German-silver. When currents of great strength are required, but not of great electromotive force, the coils are coupled up in parallel arc, instead of being united in series.

In a dynamo by Lachaussée, which very strikingly resembles the preceding one, there is iron in the cores of the rotating coils. But the main difference is that the rotating coils are the field magnets, excited by a separate Gramme dynamo, whilst the coils, which are fixed in two crowns on either side, act as armature coils in which currents are induced.

Gordon's dynamo, the largest yet constructed (Fig. 40, p. 152), is constructed on the same lines as the Lachaussée machine; but with many important improvements. In the first place, there are twice as many coils in the fixed armatures as in the rotating magnets, there being 32 on each side of the rotating disk, or, in all, 64 moving coils; while there are 64 on each of the fixed circles, or 128 stationary coils in all. The latter are of an elongated shape, wound upon a bit of iron boiler-plate, bent up to an acute V-form, with cheeks of

perforated German silver as flanges. The object of thus arranging the coils, so that the moving ones shall have twice the angular breadth of the fixed ones, is to prevent adjacent coils of the fixed series from acting detrimentally, by induction, upon one another. The alternate coils of the fixed series are united together in parallel arcs, so that there are two distinct circuits, in either or both of which lamps can be placed; or they can be

Fig. 40.



Gordon's Alternate-current Dynamo.

coupled up together. Great care appears to have been taken, in the construction of this large machine, to guard against the appearance of Foucault currents, by arranging the cores, frames, and coils, so that all metal parts of any size shall be slit, or otherwise structurally divided at right-angles to the direction of the induced electromotive forces.

Fig. 41.

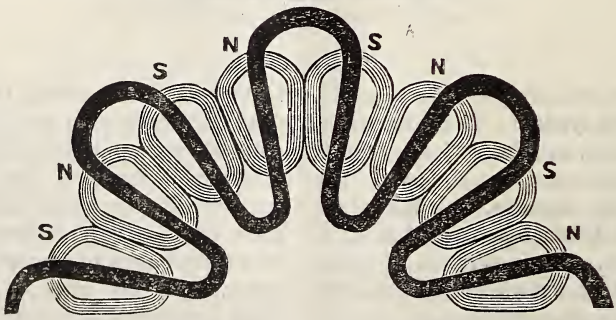
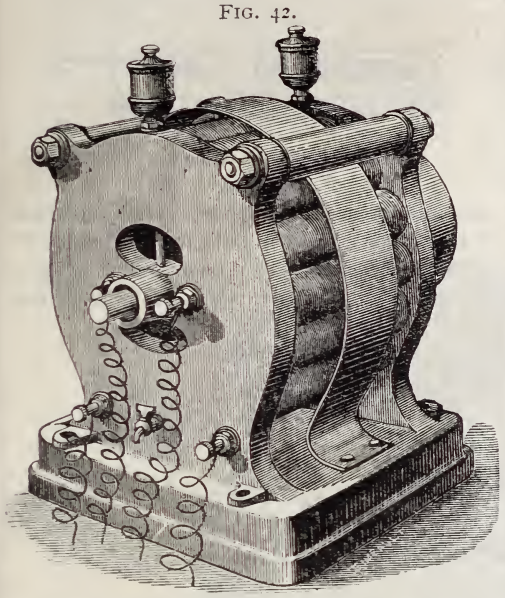


Diagram of Ferranti's Alternate-current Dynamos.

Yet another alternate-current dynamo, identical in many respects with the Siemens alternate-current dynamo, has lately been brought out, under the name of the Ferranti machine. As in the machines of Wilde and Siemens, the electro-magnets form two crowns with opposing poles. The point of difference is the armature, which, like that of Siemens,

has no iron cores in its coils; but which, unlike that of Siemens, is not made up of coils wound round cores, but consists of zigzags of strip copper folded upon one another. There are eight loops in the zigzag (as shown in Fig. 41, p. 152) which depicts half

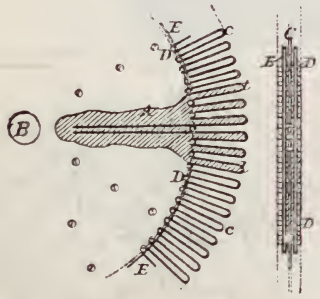
Fig. 42.



Ferranti's Alternate-current Dynamo.

only of the arrangement), and on each side are sixteen magnet poles; so that, as in Gordon's dynamo, the moving parts are twice the angular breadth of the fixed parts. Fig. 42, which gives a general view of this machine, should be compared with the Siemens machine of Fig.

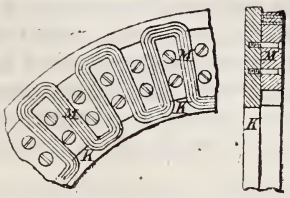
Fig 43.



Sir W. Thomson's Zigzag Winding of Armature for Alternate-current Dynamo.

39 (p. 151). The advantage of the armature of zigzag copper lies in its simplicity of construction. Sir W. Thomson, who is the real inventor of this armature, proposed originally that the copper strips should be wound between projecting teeth on a wooden wheel, as indicated in Fig. 43, which is taken from the drawings of his British patent of December, 1881. He also proposed to use as field-magnets a form of electro-magnet of the kind known as Roberts's, and also used by Joule, in which the wires that bring the exciting current are passed up and down, in a zigzag form, between iron blocks projecting from an iron

Fig. 44.

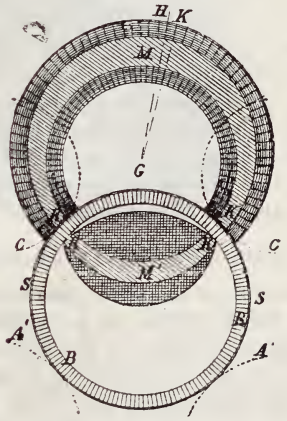


Sir W. Thomson's proposed Field-magnets.

frame. Fig. 44 shows the form, as indicated in the specification, the conducting strips being wound round between wrought-iron projections screwed to a cast-iron frame. I am not aware that this particular suggestion has been adopted as yet in practice.

Much more might be said concerning the two machines last described—the Gordon and the Thomson dynamos—but time does not

Fig. 45.



Sir W. Thomson's "Mouse-mill" Dynamo.

permit me to dwell longer upon them. And, indeed, I am not at all convinced that this type of machine, though at present it appears to be the fashionable one, is destined to prove of such very great value, simply because I doubt whether any dynamo that yields alternate currents can compete with continuous-current machines. For the purposes of a general

system of distribution, where more than one dynamo must be available, and also for the purpose of supplying motors, alternate-current machines are quite out of the question. I will not therefore dwell longer upon them, than merely to remark that, besides the disk armatures now described, pole armatures have been employed in alternate-current machines by Gramme, Jablochkoff, and by Lontin. Hefner Alteneck has gone a stage further, and, by the device of employing a disk armature in which the number of coils differed by two, or some other even number, from those of the field, and by the employmeent of a multiple-bar collector with complicated cross connections, has succeeded in converting this type of dynamo into a continuous-current machine.

Thomson's "Mouse-mill" Dynamo.

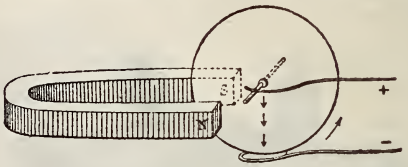
One other dynamo, not belonging to the type I have been dealing with, is worthy of mention. This is Sir W. Thomson's "mouse-mill" dynamo, shown in Fig. 45 (p. 153), in diagram. I have noticed, *en passant*, several points in this machine—the form of its field-magnets and their coils, the internal electro-magnets, &c. The armature is a hollow cylinder, S S, made up of parallel copper bars, arranged like the bars of a mouse-mill (whence the name of the machine). These bars are insulated from each other, but are connected all together at one end. At the other, they serve as collector-bars, and deliver up the currents generated in them to the "brushes," which here are rotating disks of springy copper shown as dotted circles at C C in the figure. As the armature is a hollow barrel, with fixed electro-magnets within, it cannot be rotated on a spindle, but runs on friction rollers, A A', by one or more of which it is driven.

Dynamos of the Third Class.

I now come to the third class of dynamos—those in which rotation of a conductor effects a continuous increase in the number of lines of force cut by the device of arranging one part of the conductor to slide on or round the magnet.

The earliest machine which has any right to be called a dynamo was, in fact, of this class. Barlow and Sturgeon had shown that a copper disk, placed between the poles of a magnet, Fig. 46, rotates in the magnetic field when traversed by an electic current from its axis to its periphery, where there is a sliding contact. Faraday, in 1831, showed that by rotating a similar disk mechanically between the poles of a magnet continuous currents were obtained. These he drew off by collecting springs of copper or lead, one of which touched the axis (see Fig. 47), whilst the other pressed against

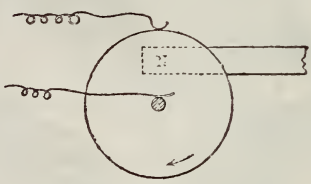
Fig. 46.



Barlow's Wheel.

the amalgamated periphery. He was thus "able to construct a new electrical machine."* "Here, therefore, was demonstrated the production of a permanent (*i.e.* continuous) cur-

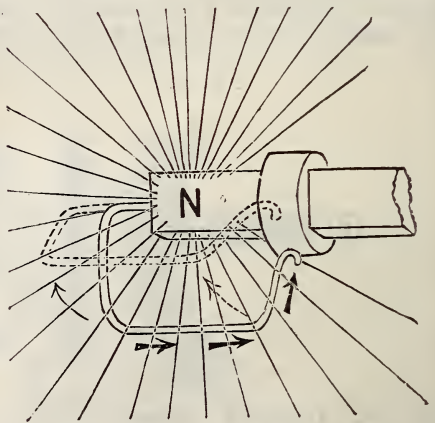
Fig. 47.



Faraday's Disk-Dynamo.

rent of electricity by ordinary magnets." But Faraday did not stop short with ordinary magnets; he went on to employ the principle of separate excitement of his field-magnets.

Fig. 48.



Rotation of Conductor about Pole of Magnet.

"These effects were also obtained from *electromagnetic poles*, resulting from the use of copper helices or spirals, either

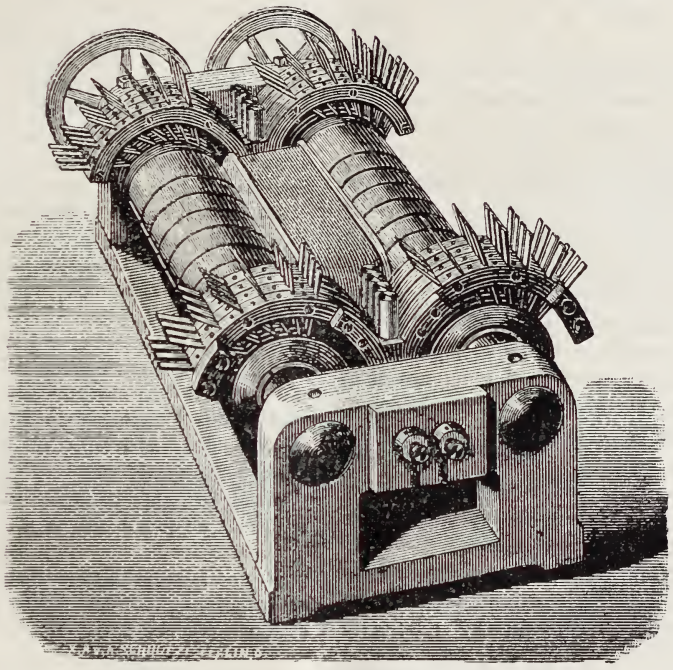
* "Experimental Researches," ¶ 83

alone or with iron cores. The directions of the motions were precisely the same; but the action was much greater when the iron cores were used, than without."* The invention of the dynamo dates, therefore, from 1831, and Faraday was its inventor, though he left to others reap the fruits of his splendid discovery.† Such a machine, however, is impracticable, for several reasons: the peripheral friction is inadmissible on any but a small scale; moreover, the disposition of the field-magnets necessarily evokes wasteful eddy-currents in the disk, which, even if slit radially, would not be an appropriate form of armature for such a limited magnetic field.

Another method of obtaining a continuous cutting of the lines of force, is indicated in Fig. 48, where a sliding conductor travels round the pole of a magnet. Faraday even generated continuous currents by rotating a magnet with a sliding connexion at its centre, from which a conductor ran round outside, and made contact with the end-pivots which supported the magnet.

A similar arrangement was devised by Mr. S. Alfred Varley, about the year 1862. He rotated an iron magnet in a vertical frame,

FIG. 49.



SIEMENS'S "UNIPOLAR" DYNAMO.

having a mercurial connexion at the centre. The current which flowed from both ends of the magnet toward the centre was, in this machine—which, by the kindness of Mr. Varley, I am able to exhibit to you to-night—made to return to the machine, and to pass through coils surrounding the poles of the rotating magnet; thus anticipating the self-exciting principle of later date. Mr. Varley also proposed to use an external electro-magnet to increase the action.

Quite recently, the same fundamental idea has been worked upon by Messrs. Siemens and Halske, who have produced a so-called "unipolar" machine* depicted in Fig. 49.

* "Experimental Researches," § 111.

† "Experimental Researches," § 158:—"I have rather, however, been desirous of discovering new facts and new relations dependent on magneto-electric induction, than of exalting the force of those already obtained; being assured that the latter would find their full development hereafter." Can any passage be found in the whole range of science more profoundly prophetic, or more characteristically philosophic, than these words, with which Faraday closed this section of his researches.

* This sounds like a *locus a non lucendo*, for the machine has two poles. But the name is derived from the term "unipolar induction," which Continental electricians give to the induc-

In this remarkable dynamo there are two cylinders of copper, both slit longitudinally to obviate eddy-currents, each of which rotates round one pole of a U-shaped electro-magnet. A second electro-magnet, placed between the rotating cylinders, has protruding pole-pieces of arching form, which embrace the cylinders above and below. Each cylinder, therefore, rotates between an internal and an external pole of opposite polarity, and consequently cuts the lines of force continuously by sliding upon the internal pole. The currents from this machine are of very great strength, but of only a few volts of electromotive force. To keep down the resistance, many collecting brushes press on each end of each cylinder. This dynamo is actually at work for electro-plating.

The only other dynamo of this class, of which I have seen any published notice, is one recently patented by Mr. E. L. Voice, in which a coil armature, wound upon an iron ring, is so placed that the iron ring is itself one pole of a magnet, a projecting pole-piece from the other pole being fixed near it, so that the coils fixed upon one pole glide round and cut the lines of force proceeding from the other pole. Whether this machine will be a practical one remains to be seen.

We are, however, far from having arrived at finality in the design and construction of dynamo-electric machines. All we can yet say is, that we appear to be approaching the time when practice will no longer be a species of blundering along into success or failure. For every day theory is more and more brought to bear in practice, and will soon enable us to predict with certainty beforehand what will be the merit of a dynamo of any particular design; and even to say not only what its cost will be, and what its efficiency and maximum duty, but also how many volts of electromotive force, and how many ampères of current it will put at our disposal. In short, the application of theory in the manufacture of dynamos must rapidly lead to great and substantial improvements in the dynamo in practice.

The Society has to thank the Editor of the *Electrician* for the loan of Figs. 1 to 4, and 10 to 19, in the first lecture, published last week, and for Figs. 20 to 25, 27 to 29, 31 to 38, 46, 47; the Editors of *Engineering* for the loan of Figs. 26, 42 to 45; Messrs. Siemens Brothers for Fig. 39; and the Editor of the *Electrical Review* for Fig. 41.

tion of currents by the process of "continuous cutting," which we are now dealing with. I do not adopt the term, as it is needlessly mystifying.

Miscellaneous.

STANDARD SCREW-THREADS.

The following particulars, as to what has been done in the United States with relation to this subject, are taken from an article in the *Railroad Gazette*, quoted in *Iron*:—

The mechanical difficulties which have stood in the way of the general adoption of a uniform or interchangeable system of screw-threads were very great. These have been overcome by the enterprise of the Pratt and Whitney Company, of Hartford, and, through them, the Master Car-builders' Association has been able to secure a standard set of gauges, on the accuracy of which the most implicit reliance may be placed. There is, however, still one step to be taken. The Franklin Institute, years ago, took what may be called the legislative step, and formulated what the standard system of screw-threads should be. The Pratt and Whitney Company then assumed judicial functions, and decided, by actual and precise measurements, what that system is. But the executive part of the reform is not yet adequately provided for. To illustrate this, let it be supposed that a railroad company is disposed to adopt the Sellers system of screw-threads. There are at present no convenient means which a master mechanic can employ, and which will enable him to be certain that the screw-threads conform with sufficient accuracy to the standard. They may, it is true, order taps and dies of the Pratt and Whitney Company, with very great confidence that they will be right; but, quite naturally, some companies say we do not wish to give a monopoly of this business to one firm or company. We want to buy taps and dies in the open market, and we want some ready means of knowing whether they are made with such precision that the interchangeability of bolts and nuts will be maintained.

The Pratt and Whitney Company is prepared to furnish duplicate gauges, but even then there comes up the question how near to the gauges taps and dies must conform. Every good practical mechanic knows that absolute precision is unattainable, and therefore, in the inspection of such tools, it will be necessary to determine how much difference is allowable.

The same thing is true of bar iron. For a long time it has been the practice of rolling mills to roll round iron over size. That is a $\frac{3}{4}$ inch bar would be 49-64ths or 25-32nds in diameter instead of 48-64ths and 24-32nds=$\frac{3}{4}$ inch. The reason for this practice, probably, was that the manufacturers found that by doing so they sold more pounds of iron. At any rate, instead of resisting the practice of the manufacturers, and to avoid cutting off the superfluous metal with the screw-cutting dyes, the master

mechanics and car-builders made their taps and dies of larger diameter, to suit the over-size of the iron.

With the introduction of the standard system of screw-threads, it has been found necessary to resist the practice of the iron makers in furnishing over-size bars, but here the same difficulty came up that is found in inspecting taps and dies, that is, to know how much variation in the diameter of bar-iron is permissible. Should it be 1-100th, or 1-64th of an inch, or half or double these amounts? Without some positive rule for receiving or rejecting iron, it is evident that what one man might accept, another would reject. It is therefore proposed to establish a limit-gauge for inspecting iron. This will consist of a plate, with two openings for each size of iron, similar to those in an ordinary wire gauge. One of these openings will be made, say, 1-100th inch smaller than the standard size, and the other 1-100th inch larger. It will then be specified that all bar-iron shall enter the one gauge, but not enter the other. This will supply a positive means of inspecting such material which will be certain, and will leave no room for question as to what should or should not be accepted.

The Pratt and Whitney Company will submit specimens of screw limit-gauges. These, we believe, are to consist of two screw plugs for each size of screw. One of these is to be a small fraction of an inch larger than the standard size, and the other the same fraction smaller. Having such gauges, a master car-builder, on receiving a lot of taps, will simply cut a sample nut with each one, and then try it on the limit-guages. If it will screw on the large gauge, the tap is too large; if it will not screw on the small one, it is too small. With such a gauge it obviously will be easy to maintain a standard system of screw-threads with a sufficient degree of precision to make bolts and nuts interchangeable, and that is all that need be aimed at.

Correspondence.

UTILISATION OF WASTE.

I thank Mr. Hugh Clements for the corrections he has made in the last *Journal* in some of my statistics. I plead guilty to having adopted figures given by Sir F. Dillon Bell in his paper which I quoted from, without testing their accuracy. That gentleman stated the imports of meat at 600,000 tons. I presume he included the weight of the live animals received and the rabbits, &c., and he also gave the average consumption of meat at 120 lbs. per head. Reasoning from the reduced number of live stock in the kingdom, I assumed that the meat production at home is less. Although the number of horned cattle keeps steady in Great Britain, averaging about 6,000,000 head, yet there has been a decline in the sheep of nearly six million in the last seven years. In 1874, the number in Great Britain was 30,313,941, in 1881, 24,581,053. Pigs, too, are less by half-a-million. With respect to the quantity of straw used for paper in the United States, I gave the exact figures in pounds in a foot-note from the census returns. In reducing the quantity into tons I hastily calculated by the American ton of 2,000 lbs., instead of 2,240 lbs., hence the slight difference which Mr. Clements points out.

P. L. Simmonds.

General Notes.

Calcutta Exhibition.—An international exhibition is to be held in Calcutta, from December 4, 1883, to February 29, 1884. The nine principal sections will be: (1) fine arts; (2) apparatus and application of the liberal arts; (3) furniture and objects used in dwellings; (4) clothing, including fabrics; (5) products of mining industry, forestry, &c.; (6) apparatus and processes in the common arts; (7) food; (8) artisans' workmanship; and (9) children's work. An attempt will also be made to hold an exhibition of live stock, agricultural and horticultural products, and of a loan collection of paintings, sculpture, and works of art generally. The usual gold, silver, and bronze medals will be awarded by special juries of experts.

Italian Cotton Industry.—The above industry has recently shown a rapid development, the consumption of the raw material having increased during 1881 by no less than 4,000 tons. The *Moniteur des fils et tissus* remarks that this quantity (taking into account the average fineness of the production) represents the work of 120,000 spindles. Another sign of the development of the spinning industry is that there has been a diminution of imports of yarns, although the Customs' duties on them are not of an onerous character. It is remarked that the Italian cotton industry has succeeded in producing yarns and cloths, which are well able to compete with similar articles of English, French, and Belgian make. The number of workpeople occupied in factories, in 1881, was 15,558 men, 27,038 women, and 11,175 children. The number of spindles is at the rate of about 1,000 for each 20 workpeople. The Messina Exhibition first showed what was the progress achieved by the Sicilian manufacturing industry. Although the cotton industry has only been established in Sicily since a comparatively recent date, it has arrived at such an extension, as to supplant almost entirely English and French goods of a similar class for the wants of the home trade of Italy. The principle feature of the Sicilian industry is the manufacture of printed cottons at a low price for current sale.

ELECTRIC LIGHT IN CHINA.—The introduction of western improvements into China by Europeans is evidently a work beset with many difficulties. Some years ago, the only railway in the country was purchased by the Government from the proprietors and promptly torn up; but now the officials themselves are laying down railroads from the mines in North China to the nearest canal. The telegraph also had to encounter a vigorous opposition from the authorities and people for many years; at present, however, the capital is connected by wire with the coast. The electric light is the latest improvement which has excited the suspicion and dislike of the Mandarins. The foreign settlement at Shanghai has for some time been lighted on the Brush system, apparently much to the comfort and jubilation of the denizens of the "model settlement," as the foreign portion of the city is generally called. The promoters appear, however, to have reckoned without the Chinese officials. They probably thought that where gas was permitted, there could be no objection to electricity. The Chinese Governor of the district appears to be of a different opinion. He has addressed a letter to the senior Foreign Consul, requesting the removal of all the electric lamps. He has read, he says, in translations from European papers, that terrible accidents have arisen from electricity, and flatly refuses to permit the residents of Shanghai to be exposed to such dreadful risks. Hundreds of thousands of houses might be destroyed, millions of lives might be lost; even the walls of the city might be blown down if anything went wrong with the machines. He has strictly forbidden his own countrymen to use it, and has peremptorily ordered those who have already adopted it to discontinue it forthwith.—*Nature*.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

DATES FIXED.

JANUARY 17.—"The Sanitary Inspection of Houses." By W. K. BURTON.

JANUARY 24.—"The Suez Canal." By GENERAL RUNDELL.

FEBRUARY 14.—"Some Points in the Practice of the American Patent Office." By SIR FREDERICK BRAMWELL, F.R.S.

DATES TO BE HEREAFTER ANNOUNCED.

"The Modern Lathe." By J. H. EVANS.

"The History of the Pianoforte." By A. J. HIPKINS.

"The Electrical Transmission of Power." By PROF. GEORGE FORBES.

"Recent Improvements in Agricultural Machinery." By D. PIDGEON.

"English and Foreign Silver Work; with Some Remarks on Hall-markings and its Advantages." By WILFRED CRIPPS, F.S.A.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at 8 o'clock:—

JANUARY 30.—"Life among the Turcoman Nomads." By EDMOND O'DONOVAN.

FEBRUARY 6.—"Social Conditions and Prospects n Madagascar." By Rev. J. PEILL.

FEBRUARY 27.—"Egypt, Present and to Come." By ROBERT W. FELKIN.

MARCH 20.—"Social and Commercial Aspects of New Zealand." By WILLIAM DELISLE HAY.

APPLIED CHEMISTRY AND PHYSICS SECTION

Thursday evenings at Eight o'clock:—

JANUARY 25.—"Technical Aspects of Lignification." By C. F. CROSS, F.C.S.

FEBRUARY 22.—

MARCH 8.—"Self-purification of River Waters." By W. N. HARTLEY, F.R.S.E.

APRIL 12.—"The Formation of Diastase from Grain by Moulds." By R. W. ATKINSON, B.Sc.

APRIL 26.—"The Application of Electrolysis to Bleaching and Printing." By JAMES J. DOBBIE, D.Sc., and JOHN HUTCHINSON.

INDIAN SECTION.

Friday evenings at Eight o'clock:—

FEBRUARY 16.—"Overland Commercial Communication between India and China, *viâ* Assam." By CHARLES H. LEPPER.

MARCH 2.—"Agriculture in Lower Bengal: with some Notice of Tenant Right, &c." By W. S. SETON-KARR.

APRIL 16.—"Private Enterprise in India." By J. M. MACLEAN.

APRIL 20.—

MAY 4.—"Some Notes on the Domestic Architecture of India." By C. PURDON CLARKE.

MAY 25.—

CANTOR LECTURES.

Monday evenings at Eight o'clock:—

Second Course, on "Solid and Liquid Illuminating Agents." By LEOPOLD FIELD.

January 29; February 5, 12, 19, 26; March 5.

Third Course, on "The Decorative Treatment of Metal in Architecture." By G. H. BIRCH.

April 2, 9, 16.

Fourth Course, on "The Transmission of Energy." By OSBORNE REYNOLDS.

April 23, 30; May 7.

Fifth Course, on "Secondary Batteries." By Prof. OLIVER J. LODGE, M.A., D.Sc.

May 21, 28.

Journal of the Society of Arts.

No. 1,573. Vol. XXX.

FRIDAY, JANUARY 12, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

On Wednesday evening, the 10th inst., Professor H. N. Moseley, M.A., F.R.S., delivered the second (and last) of the series of Juvenile Lectures, on the "Inhabitants of the Ocean," which was fully illustrated by lantern slides of the various animals inhabiting the deep sea. The lecturer first showed the different forms of dredging and trawling-nets, and explained how they were used. The *Challenger* carried twenty-five miles of the best hempen rope, and this mass occupied a large amount of space; so that the adoption of wire-rope, as suggested by American surveyors, would be a great convenience. Having explained the mode by which the animals were obtained from the deep sea, Professor Moseley proceeded to show some of the most remarkable of these. It was found that sunlight does not pierce through the water below 100 fathoms; so that any light that may exist in these depths must be obtained from the phosphorescent animals, of which there are many. The animals represented consisted of fish, sea-anemones, echinoderms, corals, &c. In concluding, the lecturer said that as there was no vegetation in the deep sea, the inhabitants had to depend for food entirely upon the dead of the surface water, which sunk down to them; and also upon such matter as was washed from the shore.

A unanimous vote of thanks to Professor Moseley for his interesting lectures, was carried, on the motion of the Chairman (Mr. W. H. Preece), who alluded to the benefits conferred on the scientific world by the voyage of the *Challenger*, not only from the light it had thrown on Biology, but also on account of the surveys which had been made of the deep sea bottom.

Proceedings of the Society.

CANTOR LECTURES.

DYNAMO-ELECTRIC MACHINERY.

By Professor Silvanus P. Thompson B.A., D.Sc., M.S.T.E.

Lecture III.—Delivered Monday, Dec. 18th

The Dynamo as a Motor.

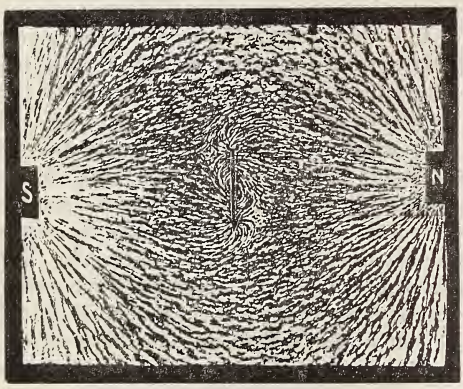
In my first lecture, I laid down the definition that dynamo-electric machinery means "machinery for converting the energy of mechanical motion into the energy of electric currents, or *vice versa*." In the two lectures which I have already had the honour of delivering, I have treated the dynamo solely in its functions as a generator of electric currents. In this third lecture I come to the converse function of the dynamo, namely, that of converting the energy of electric currents into the energy of mechanical motion.

An electric-motor, or, as it was formerly called, an electro-magnetic engine, is one which does mechanical work at the expense of electric energy; and this is true, no matter whether the magnets which form the fixed part of the machine be permanent magnets of steel or electro-magnets. Any one, in fact, of the four kinds of dynamo, can be used conversely as a motor, though, as we shall see, some more appropriately than others. But whether their field-magnets be of permanently magnetised steel or of temporarily magnetised iron, all these motors are electro-magnetic in principle; that is to say, there is some part either fixed or moving which is an electro-magnet, and which as such attracts and is attracted magnetically.

Every one knows that a magnet will attract the opposite pole of another magnet, and will pull it round. We know also that every magnet placed in a magnetic field tends to turn round and set itself along the lines of force. Let me, as a first illustration of this class of actions, exhibit to you the nature of the forces at work in the magnetic field. In the figure which I now throw upon the screen (Fig. 50, p. 160), we have, in the first place, a simple magnetic field produced between the poles of two strong magnets, one on the right, the other on the left. Between the two, confined forcibly at right-angles to the lines of force, I hold a small magnetic needle. Iron filings sprinkled

in the field reveal the actions at work in a most instructive way. Faraday, who first taught us the significance of these mysterious lines of force, has told us that we may reason about them as if they tended to contract or grow shorter. Now a simple inspection of Fig. 50 will show that the shortening of the lines of force must have the effect of rotating the magnetic needle upon its centre, through an angle of 90°, for the lines stream away on the right hand above, and on the left hand below, in a most suggestive fashion. It is not, therefore, difficult to understand that very soon after the invention of the electro-magnet, which gave us for the first time a magnet whose power was under control, a number of ingenious persons perceived that it would be possible to construct an electro-magnetic engine in which an electro-magnet, placed in a magnetic field,

Fig. 50.



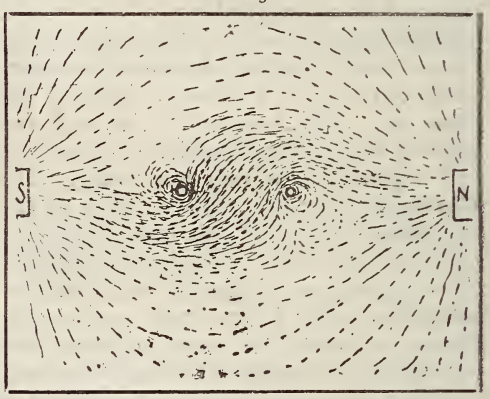
Action of Magnetic Field on a Magnetic Needle.

should be pulled round; and, further, that the rotation should be kept up continuously, by reversing the current at an appropriate moment. As a matter of fact, a mere coil of wire, carrying a current, is acted upon when placed in the magnetic field, and is pulled round as a magnet is. Fig. 51 shows how, in this case, the lines of force reveal the action. The magnetic field is, as before produced, between the ends of two large magnets. The two round spots are two holes drilled in the sheet of glass, where the wire which carried the current came up through the glass and descended again. You will notice how the lines of iron filings, which would, if there were no current, run simply across from left to right, are bent out of their course. If these lines could shorten themselves, they must, of necessity, twist the loop of wire round, and cause it to set at right angles to its present position.

On this very principle was constructed the earliest electric-motor of Ritchie, so well known in many forms as a stock piece of electric apparatus, but little better in reality than a toy.

A great step in advance was made by Jacobi, who, in 1838, constructed the multipolar machine, of which we give a representation in Fig. 52 (p. 161). This motor, which Jacobi designed for his electric boat, had two strong wooden frames, A and B, in each of which a dozen electro-magnets were fixed, their poles being set alternately. Between them, upon a wooden disk, were placed another set of electro-magnets, which, by the alternate attraction and repulsion of the fixed poles were kept in rotation, the current which traversed the rotating magnets being regularly

Fig. 51.



Action of Magnetic Field on a Wire carrying a Current.

reversed at the moment of passing the poles of the fixed magnets, by means of a commutator consisting, according to Jacobi's directions, of four brass-toothed wheels, having pieces of ivory or wood let in between the teeth for insulation. Jacobi's motor is, in fact, a very advanced type of dynamo, and differs very little in point of design from one of Wilde's most successful forms.*

A still earlier rotating apparatus, and, like Ritchie's motor, a mere toy, was Barlow's wheel, Fig. 46 (p. 154), described in 1823. This instrument, interesting as being the forerunner of Faraday's disk dynamo, is the representative of an important class of machines,

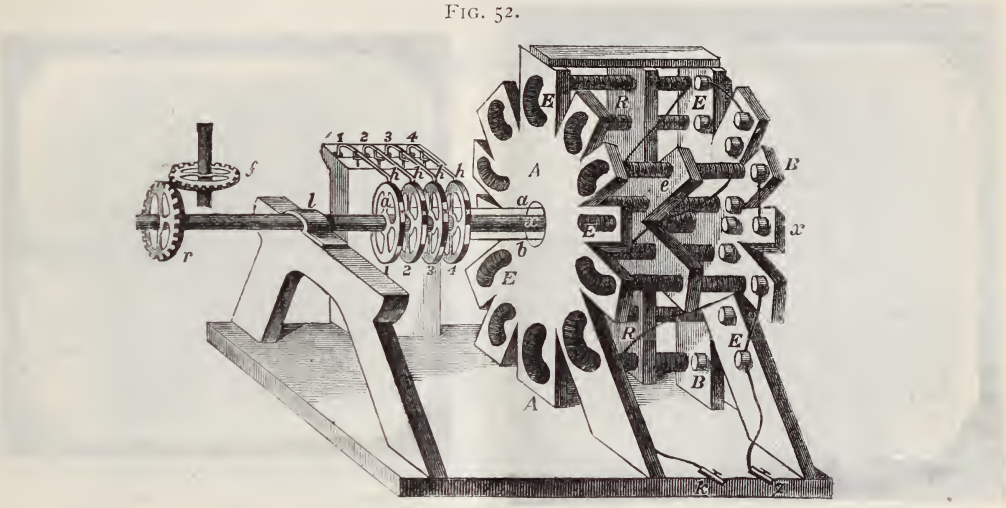
* Wilde's is, however, designed as a generator. Jacobi's, on the contrary, was designed as a motor; though, of course, it would generate currents if driven round by mechanical power.

namely, those which have a sliding contact merely, and need no commutator.

A fourth class of motors may be named, wherein the moving part, instead of rotating upon an axis, is caused to oscillate backwards and forwards. Professor Henry, to whom we owe so much in the early history of electro-magnetism, constructed, in 1831, a motor with an oscillating beam, alternately drawn backwards and forwards by the intermittent action of an electromagnet. Dal Negro's motor of 1833 was of this class ; in it a steel rod was caused to oscillate between the poles of an electro-magnet, and caused a crank, to which it was geared, to rotate in consequence. A distinct improvement in this type of machine was introduced by Page, who employed hollow coils or bobbins as electro-magnets, which, by their alternate action, sucked down iron cores into the coils, and caused them to oscillate to and fro. Motors of this kind form an admirable illustration of one of the laws of electro-magnetics, first formulated by Gauss, but developed later by Maxwell, to the effect that a circuit acts on a magnetic pole in such a way as to make the number of magnetic lines of force that pass through the circuit a maximum. Once more I have recourse to iron filings to illustrate this abstract proposition of electric geometry.

In the figure before you (Fig. 53, p. 162), the north pole of a bar magnet is placed opposite a circuit or loop of wire traversed by a current, and which comes up through the glass at the lower hole, and descends at the upper hole. The tendency to draw as many as possible of the magnet's lines of force into the embrace

Fig. 52.



Jacobi's Electric Motor (1838).

of the circuit is unmistakeable. If now we reverse the current, what do we find? Fig. 54 (p. 162) supplies the answer ; for now we find that the magnet's lines of force, instead of being drawn in, are pushed out. In fact, in one case, the pole is attracted in, the other repelled.

Page's suggestion was further developed by Bourbouze, who constructed the curious motor depicted in Fig. 55 (p. 163),* which looks uncommonly like an old type of steam-engine. We have here a beam, crank, fly-wheel, connecting-rod, and even an eccentric valve-gear and a slide valve. But, for cylinders, we have four hollow electro-magnets ; for pistons, we have iron cores, that are alternately sucked in and repelled out ; and, for slide valve, we have a commutator, which, by dragging a pair of platinum-tipped springs over a flat surface made of three pieces of brass separated by two insulating strips of ivory, reverses at every stroke the direction of the currents in the coils of the electro-magnets. It is really a very ingenious machine, but, in point of efficiency, far behind many other electric motors. Unfortunately, it does not do to design dynamo-electric machinery on the same lines as steam-engines.

Yet, a fifth class of electric motors owes its existence to Froment, who, fixing a series of parallel iron bars upon the periphery of a drum, caused them to be attracted, one after the other, by an electro-magnet or electro-

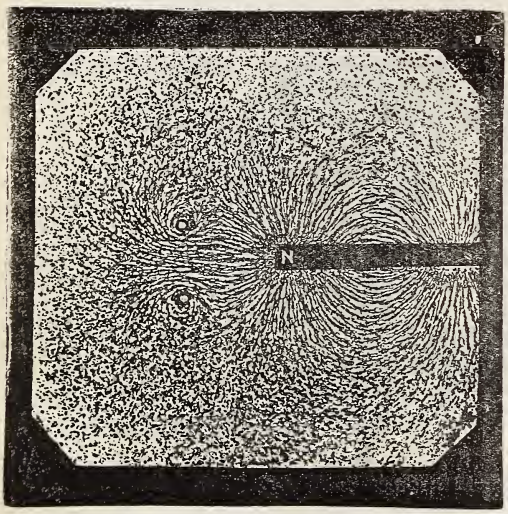
* Taken, by permission of Messrs. Macmillan and Co., from "The Application of Physical Forces."

magnets, and thus procured a continuous rotation.

Lastly, of the various types of motor we may enumerate a class in which the rotating portion is enclosed in an eccentric frame of iron, so that as it rotates, it gradually approaches nearer. Little motors, working on this principle of "oblique approach," were invented by Wheatstone, and have long been used for spinning Geissler tubes, and other light experimental work. More recently, Trouvé and Wiesendanger have sought to embody this principle in motors of more ambitious proportions, but without securing any great advantage.

It would be impossible, within the limits of a lecture, to deal with a tithe of all the various

FIG. 53.



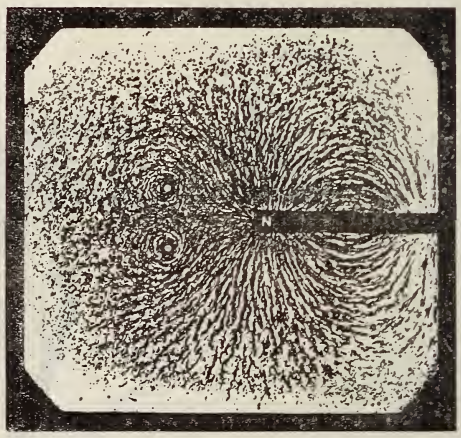
POLE OF MAGNET ATTRACTED INTO A CIRCUIT TRAVERSED BY A CURRENT.

stages of discovery and invention, and if it were my intention to deal with the subject from the historical point of view, I might speak of many interesting and curious machines that have from time to time been tried. I might tell you how Page, after inventing his machine in 1834, succeeded, in 1852, in constructing a motor of such a size that he was able to drive a circular saw and a lathe by it. I might describe the electric-motor of Davidson, which, in 1842, enabled him to propel a carriage, at the speed of four miles an hour, between Edinburgh and Glasgow. I might describe the engine, built in 1849, by Soren Hjörth, at Liverpool, which was of ten-horse power.

All these early attempts, however, came to nothing, for two reasons. At that time there was no economical method of generating electric currents known. At that time, moreover, the great physical law of the conservation of energy was not recognised, and its all-important bearings upon the theory of electric machinery were not available.

While voltaic batteries were the only available sources of electric currents, economical working of electric motors was hopeless. For a voltaic battery, wherein electric currents are generated by dissolving zinc in sulphuric acid, is a very expensive source of power. To say nothing of the cost of the acid, the zinc—the very fuel of the battery—costs more than twenty times as much as coal, and is a far worse fuel; for whilst an ounce of zinc will evolve heat to an amount equivalent to 113,000 foot-pounds

FIG. 54.



POLE OF MAGNET REPELLED OUT OF THE CIRCUIT WHEN THE CURRENT IS REVERSED.

of work, an ounce of coal will furnish the equivalent of 695,000 foot-pounds.

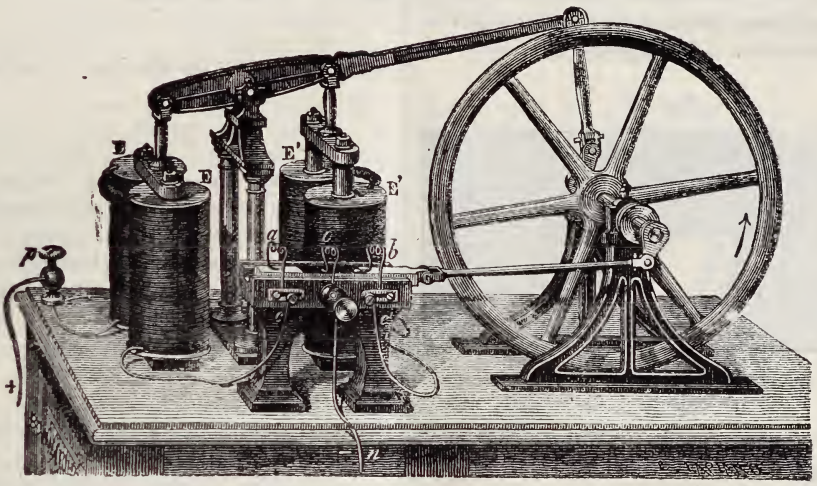
The fact, however, which seemed most discouraging, and which, if rightly interpreted in accordance with the law of conservation of energy, would have been found to be (on the contrary) a most encouraging fact, was the following:—If a galvanometer was placed in the circuit with the electric-motor and the battery, it was found that when the motor was running it was impossible to force so strong a current through the wires as that which flowed when the motor was standing still. Now there are only two causes that can stop such a current flowing in a circuit; there must be either an obstructive resistance or else a counter-electromotive force. At first, the common idea was that, when the motor was

spinning round, it offered a greater resistance to the passage of the electric current than when it stood still. The genius of Jacobi enabled him, however, to discern that the observed diminution of current was really due to the fact that the motor, by the act of spinning round, began to work as a dynamo on its own account, and tended to set up a current in the circuit in the opposite direction to that which was driving it. The faster it rotated the greater was the counter-electromotive force (or "electromotive force of reaction") which was developed. In fact, the theory of the conservation of energy requires that such a reaction should exist.

We know that, in the converse case, when we are employing mechanical power to generate currents by rotating a dynamo, directly we begin to generate currents, that is to say, directly we begin to do electric *work*, it immediately becomes much harder work to turn the dynamo than is the case when no electric work is being done. In other words, there is an opposing reaction to the mechanical force which we apply in order to do electric work. An opposing reaction to a mechanical force may be termed a "counter-force." When, on the other hand, we apply (by means of a voltaic battery, for example) an electromotive force to do mechanical work, we find that here again there is an opposing reaction; and an opposing reaction to an electromotive force is a "counter-electromotive force."

The experiment of showing the existence of

Fig. 55.



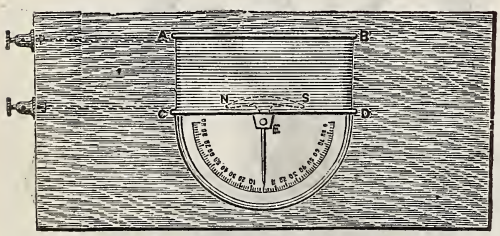
Bourbouge's Electromotor.

this counter-electromotive force is a very easy one. All one requires is a little motor, a few cells of battery, and a galvanometer. The galvanometer I shall use to-night is one which I brought out some years ago, and which has proved itself very convenient for lecture work, because it can be put into any ordinary lantern and projected on the screen (Fig. 56, p. 164). I have here, as a battery, four small accumulators of the Faure-Sellon-Volckmar type, and I have connected them with a little motor, also of my own design, the current being arranged so as to run through the galvanometer. I hold the spindle of the motor fast, so that it cannot rotate, and you see that the pointer of the galvanometer indicates 44°. I now release the motor; it begins to rotate, and as its speed increases, you observe the needle descend the scale to 23°, and eventually to about 15°. If I load the motor and cause it to slacken speed, the needle at once returns.

The existence of this counter-electromotive force is of the utmost importance, in considering the action of the dynamo as a motor, because upon the existence and magnitude of this counter-electromotive force, depends the degree to which any given motor enables us to utilise electric energy that is supplied to it in the form of an electric current. In discussing the dynamo as a generator, I pointed out many considerations, the observance of which would tend to improve the efficiency of such generators. It is needless to say that many of these considerations, such as the avoidance

of useless resistances, unnecessary iron masses in cores, and the like, will also apply to motors. The freer a motor is from such objections, the more efficient will it be. But the efficiency of a motor in utilising the energy of a current depends not only on its efficiency in itself, but on another consideration, namely, the relation between the electromotive force which it itself generates when rotating, and the electromotive force—or, as some people call it, the electric pressure—at which the current is supplied to it. A motor which itself in running generates only a *low* electromotive force cannot, however well designed, be an *efficient* or economical motor when supplied with currents at a *high* electromotive force. A good low-pressure steam-engine does not become more "efficient" by being supplied with high-pressure steam. Nor can a high-pressure steam-engine, however well constructed, attain a high efficiency when worked with steam at low pressures. Analogous considerations

FIG. 56.



S. P. THOMPSON'S LANTERN GALVANOMETER.

apply to dynamos used as motors. They must be supplied with currents at electromotive forces adapted to them. Even a perfect motor—one without friction or resistance of any kind—cannot give an "efficient" or economical result, if the law of efficiency is not observed in the conditions under which the electric current is supplied to it.

Now it can be shown, mathematically, that the efficiency with which a perfect motor utilises the electric energy of the current depends upon the ratio between this counter-electromotive force and the electromotive force of the current that is supplied by the battery. No motor ever succeeds in turning into useful work the whole of the currents that feed it, for it is impossible to construct machines without resistance, and whenever resistance is offered to a current part of the energy of the current, it is wasted in heating the resisting wire. Let the symbol W stand for the whole electric energy of a current, and let w stand for that part of the energy which the motor takes up as useful work from the circuit.* All the rest of the energy of the current, or W—w, will be wasted in useless heating of the resistances.

But, if we want to work our motor under the conditions of greatest economy, it is clear that we must have as little heat-waste as possible; or, in symbols, w must be as nearly as possible equal to W. It can be shown, mathematically, that the ratio between the useful energy thus appropriated, and the total energy spent, is equal to the ratio between the counter-electromotive force of the motor, and the whole electromotive force of the battery that feeds the motor. The proof will be given later. Let us call this whole electromotive force with which the battery feeds the motor E, and let us call the counter-electromotive force e. Then the rule is

$$w : \mathrm{W} = e : \mathrm{E}$$

or, if we express the efficiency as a fraction,

$$\frac{w}{\mathrm{W}} = \frac{e}{\mathrm{E}}$$

But we may go one stage further. If the resistances of the circuit are constant, the current c, observed when the motor is running, will be less than C, the current while the motor was standing still. But, from Ohm's law, we know that

$$c = \frac{\mathrm{E} - e}{\mathrm{R}}.$$

Hence $\frac{\mathrm{C} - c}{\mathrm{C}} = \frac{e}{\mathrm{E}} = \frac{w}{\mathrm{W}}$. From which it appears that we can calculate the efficiency at which the motor is working, by observing the ratio between the fall in the strength of the current and the original strength. Now, this mathematical law of efficiency has been known for twenty years,† but has been strangely misapprehended. Another law, discovered by

* This symbol w must be clearly understood to refer to the value of the work taken up by the motor, as measured electrically. The whole of this work will not appear as useful mechanical effect, however, for part will be lost by mechanical friction, and part also in the wasteful production of eddy-currents in the moving parts of the motor. What proportion of w appears as useful mechanical work depends on the efficiency of the motor *per se*, which we are not here considering. In all that follows immediately we shall suppose such causes of loss not to exist; or the motor will be considered as a perfect motor.

† See Verdet's "Théorie Mécanique de la Chaleur," where, however, Verdet makes the very mistake so often made, of supposing that the greatest possible efficiency of a motor, working with a given electromotive force, is 50 per cent, or its efficiency when working at the maximum rate.

Jacobi, not a law of efficiency at all, but a law of maximum work in a given time, has usually been given instead.

Jacobi's law concerning the maximum work of an electric motor supplied with currents from a source of given electromotive force, is the following:—The mechanical work given out by a motor is a maximum when the motor is geared to run at such a speed that the current is reduced to half the strength that it would have if the motor was stopped. This, of course, implies that the counter-electromotive force of the motor is equal to half the electromotive force furnished by the battery or generator. Now, under these circumstances, only half the energy furnished by the external source is utilised, the other half being wasted in heating the circuit. If Jacobi's law were indeed the law of efficiency, no motor, however perfect in itself, could convert more than 50 per cent. of the electric energy supplied to it into actual work. Now Siemens showed,* some years ago, that a dynamo can be, in practice, so used as to give out more than 50 per cent. of the energy of the current. It can, in fact, work more efficiently if it be not expected to do its work so quickly. Dr. Siemens, to whom we owe the honour of having first shown us the true physical signification of the mathematical expressions which, until then, had been regarded as mere abstractions, has, in fact, proved that if the motor be arranged so as to do its work at less than the maximum rate, by being geared so as to do much less work per revolution, but yet so as to run at a higher speed, it will be more efficient; that is to say, though it does less work, there will also be still less electric energy expended, and the ratio of the useful work done to the energy expended will be nearer unity than before.

The algebraic reasoning is as follows:—If E be the electromotive force of the generator when the motor is at rest, and c be the current which flows at any time, the electric energy, W, expended in unit time, will be (as expressed in watts) given by the equation

$$W = Ec = E\frac{(E - e)}{R} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Now, when the motor is running, part of this electric energy is being spent in doing work, and the remainder is wasting itself in heating the wires of the circuit. We have already used the symbol w for the useful work (per second) done by the motor. All the energy which is not thus utilised is wasted in heating the resistances. Let the symbol H represent this heat. Its mechanical value will be HJ, where J stands for Joule's equivalent. Then clearly we shall have

$$W = w + HJ.$$

But, by Joule's law, the heat-waste of the current, whose strength is c running through resistance R, is expressed by the equation

$$HJ = c^2 R.$$

Substituting this value above, we get

$$W = w + c^2 R, \quad . \quad . \quad . \quad (2)$$

which we may also write

$$w = W - c^2 R.$$

But by equation (1) $W = Ec$, whence

$$w = Ec - c^2 R, \quad . \quad . \quad . \quad . \quad (3)$$

and, writing for c its value, $\frac{E - e}{R}$, we get:

$$w = \frac{(E - e)\ (E - \{E - e\})}{R}$$

$$\text{or } w = e\frac{E - e}{R} \quad . \quad . \quad . \quad . \quad . \quad (4).$$

Comparing equation (5) with equation (1), we get the following:—

$$\frac{w}{W} = \frac{e\,(E - e)}{E\,(E - e)}$$

or, finally—

$$\frac{w}{W} = \frac{e}{E}$$

This is, in fact, the mathematical law of efficiency, so long misunderstood until Siemens showed its significance. We may appropriately call it the law of Siemens.

Here the ratio $\frac{w}{W}$ is the measure of the efficiency of the motor, and the equation shows that we may make this efficiency as nearly equal to unity as we please, by letting the motor run so fast that e is very nearly equal to E: which is the true law of efficiency of a perfect motor supplied with electric energy, under the condition of constant external electromotive force.

Now go back to equation (3), which is:—

$$w = Ec - c^2 R$$

In order to find what value of c will give us the maximum value for w (which is the work

* The matter was also very well and clearly put by Prof. W. E. Ayrton, in his lecture on "Electric Transmission of Power," before the British Association in Sheffield, in 1879.

done by the motor in unit time, we must take the differential coefficient and equate it to zero.

$$\frac{dw}{dc} = E - 2cR = o$$

whence we have

$$c = \tfrac{1}{2}\frac{E}{R}$$

But, by Ohm's law, $\frac{E}{R}$ is the value of the current when the motor stands still. So we see at once that, to get maximum work per second out of our motor, the motor must run at such a speed as to bring down the current to half the value which it would have if the motor were at rest. In fact, we here prove the law of Jacobi for the maximum rate of doing work. But here since—

$$c = \frac{E-e}{R} = \tfrac{1}{2}\frac{E}{R}$$

it follows that—

$$E - e = \tfrac{1}{2}E;$$

or

$$\frac{e}{E} = \tfrac{1}{2},$$

whence it follows also that—

$$\frac{w}{W} = \tfrac{1}{2}.$$

That is to say, the efficiency is but 50 per cent. when the motor does its work at the maximum rate.*

* It may be worth while to recal a precisely parallel case that occurs in calculating the currents from a voltaic battery. Every one is familiar with the rule for grouping a battery which consists of a given number of cells, that they will yield a maximum current through a given external resistance when so grouped that the internal resistance of the battery shall, as nearly as possible, equal the external resistance. But this rule, which is true for maximum current (and, therefore, for maximum rate of using up the zincs of one's battery) is not the case of greatest economy. For if external and internal resistance are equal, half the energy of the current will be wasted in heat in the cells, and half only will be available in the external circuit. If we want to get the greatest economy, we should group our cells so as to have an internal resistance much less than the external. We shall not get so strong a current, it is true; and we shall use up our zincs more slowly; but a far greater proportion of the energy will be expended usefully, and a far less proportion will be wasted in heating the battery cells. The maximum economy will, of course, be got by making the external resistance infinitely great as compared with the internal resistance. Then all the energy of the cement will be utilised in the external circuit, and none wasted in the battery. But it would take an infinitely long time to get through a finite amount of work in this extreme. The same kind of reasoning is strictly applicable to dynamos used as generators, the resistance of the rotating part of the circuit being the counterpart to the internal resistance of the battery cells. For good economy the resistance of the armature should be very low as compared with that of the external circuit. Mr. Edison seems to have been struck by this point, as his endeavours to reduce the resistance of his armature coils to the utmost limit of possibility show.

Now, though several graphic constructions have been suggested to convey these facts to the eye, none have hitherto been, to my mind, quite satisfactory. I have, therefore, worked out a new construction, which enables me, in one diagram, to exhibit graphically both Jacobi's law of maximum rate of working, and Siemens's law of efficiency.

Let the vertical line, A B (Fig. 57), represent the electromotive force, E, of the electric supply. On A B construct a square, A B C D, of which let the diagonal, B D, be drawn. Now measure out from the point, B, along the line, B A, the counter-electromotive force, e, of the motor. The length of this quantity will increase as the velocity of the motor increases. Let e attain the value B F. Let us inquire what the actual current will be, and what the energy of it; also what the work done by the motor is. First complete the construction as follows:—Through F draw F G H, parallel to B C, and through G draw K G L, parallel to A B,

FIG. 57.

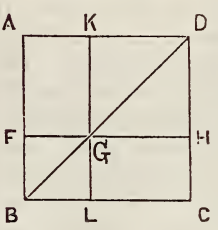
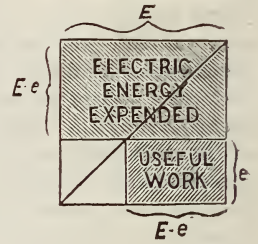


FIG 58.



Then the actual electromotive force at work in the machine, and producing the current, is E—e, which may be represented by any one of the lines, A F, K G, G H, or L C. Now the electric energy expended per second is—

$$\frac{E\ (E-e)}{R}$$

and the work done by the motor is—

$$\frac{e\ (E-e)}{R}$$

Since R is a constant, the relative values of the two may be written respectively—

$$E\ (E-e)$$

and

$$e\ (E-e).$$

Now

area A F H D = E (E—e),

and

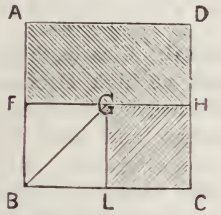
area G L C H = e (E—e):

The ratio of these two areas on the diagram is the efficiency of the motor.

Let us turn to Fig. 58 (p. 166), in which these areas are shaded. This figure represents a case where the motor is too heavily loaded, and can turn only very slowly, so that the counter-electromotive force e is very small compared with E. Here the area, which represents the energy expended, is very large; while that which represents useful work realised in the motor is very small. The efficiency is obviously very low. Two-thirds or more of the energy is being wasted in heat.

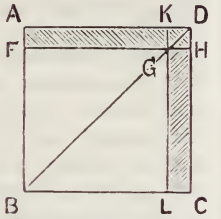
Next, let us turn our attention to the smaller area, G L C H. Obviously, the value of this area will depend upon the position of the point F; for if F is very near B, the area will be very small. If F moves upward, the area, G L C H, will have a value that increases up to a certain point, and then diminishes again; for if F be taken very near A (that is, if e be very nearly equal to E), the area, G L C H, will become again a very narrow strip. Of all the possible cases, the area of this rectangle will

FIG. 59.



GEOMETRIC ILLUSTRATION JACOBI'S LAW OF MAXIMUM RATE OF DOING WORK.

FIG. 60.



GEOMETRIC ILLUSTRATION SIEMENS'S LAW OF EFFICENCY.

be a maximum when G is midway between B and D; for of all possible rectangles that can be inscribed in the triangle, B C D, that rectangle which is a true square will have the greatest value, as drawn in Fig. 59. But if G is midway between B and D, the rectangle, G L C H, will be exactly half the area of the upper rectangle, A F H D; which is, in fact, Jacobi's law of the efficiency of a motor doing its work at its greatest possible rate. Also F will be halfway between B and A, which signifies that $e = \frac{1}{2}$ E.

Again, consider these two rectangles when the point G moves indefinitely near to D (Fig. 60). We know, from Euclid's Second Book, familiar from our school-days, that the rectangle, G L C H, is equal to the rectangle, A F G K. The area (square), K G H D, which is the excess of A F H D, over A F G K, must, therefore, represent that part of the electric energy which is wasted in heating the resistance of the motor and circuit. In Fig. 58 (p. 166) this corner square, which stands for the heat-waste, was enormous. In Fig. 59 it was exactly half the energy. In Fig. 60 it is only about one-eighth. Clearly, we may make the heat-waste as small as we please, if only we will take the point F very near to A. The efficiency will be a maximum when the heat-waste is a minimum. The ratio of the areas, G L C H and A F H D, which represents the efficiency, can only become equal to unity when the square, K G H D, becomes indefinitely small; that is, when the motor runs so fast that its counter-electromotive force, e, differs from E by an indefinitely small quantity only. Further, it is clear that if our diagram is to represent any given efficiency—for example, an efficiency of 90 per cent., then the point, G, must be taken so that the area G L C H = 9-10ths of the area A F H D; or G must be 9-10ths of the whole distance along B D. This involves that e shall be equal to 9-10ths of E, or that the motor shall run so fast as to reduce the current to 1-10th of what it would be if the motor were standing still. Thus we verify, geometrically, Siemens's law of efficiency.*

In all the preceding discussion, I have supposed that the motor is to be worked with a supply of current furnished at a fixed electromotive force. It is not only convenient, but I believe wise, to make such a condition the basis of the argument, because this is, probably, the condition under which electric power will, in the not very distant future, be distributed over large areas. It would be absurd, in the present stage of electro-technical science, to deal with such a question as the construction and use of motors, without taking into account the practical conditions under which they will be used. It is true that the condition of having a constant fixed electromotive force is not the only condition of supply; for, as we have seen in preceding lectures, a generator or system of generators may be worked so as to yield a constant current. And it would be quite possible to formulate a set of rules for the efficiency and maximum duty of motors

* We have all along supposed the motor to be a "perfect" one, that is to say, one which gave out as available mechanical work all the electric work it took from the supply of energy of the current. No motor does this, because of friction, &c. But it is easy to adapt the construction to the case. Suppose when working the motor as a generator, so as to give an electromotive force, e, we found that it was capable of converting 80 per cent. of mechanical energy into electrical energy; then we may put down the efficiency of the motor, *per se*, under the given conditions at 80 per cent. All we have, then, to do is to take an area 8-10ths of the size of the area G L C H (or cut off 1-5th of G L C H), and this will really represent the available mechanical work of the motor.

under this condition. But this method of distributing electric power is far less likely to be of importance in the near future, than the system of distribution with constant electromotive force; though for the case of transmission of power to an isolated station, the case becomes of importance. One simple problem connected with this case is worthy of mention. Suppose that one is desirous of working a motor, so as to do work at the rate of a specified number of horse-power, and that the wire available to bring the current cannot safely stand more than a certain current, without being in danger of becoming heated unduly. It might be desirable to know what electromotive force such a motor ought to be capable of giving back, and what electromotive force must be applied at the transmitting end of the wire. Let N stand for the number of horse-power to be transmitted, and c for the maximum strength of current that the wire will stand (expressed in ampères.) Then, by the known rule for the work of a current, since—

$$\frac{ec}{746} = N,$$

$$e = \frac{746\ N}{c}$$

gives the condition as to what electromotive force the machine must be capable of giving, when run at the speed it is eventually to run at as a motor. Moreover, the primary electromotive force, E, must be such that

$$\frac{E-e}{\Sigma R} = c$$

where ΣR is the sum of all the resistances in the circuit. Whence,

$$E = e + c\Sigma R.$$

Which is the required condition.

Another problem in the application of motors to transmission of power, which vitally affects their construction, is the determination of the relation of the heat-waste to the electromotive force at which the current is supplied to the motor.

If, as before, ΣR stands for the sum of all the resistances in the circuit; then, by Joule's law, the heat waste is (in mechanical measure)

$$HJ = C^2\Sigma R.$$

And, since $c = \frac{E-e}{\Sigma R}$ we may write the heat-waste as

$$HJ = \frac{(E-e)^2}{\Sigma R}$$

Now suppose that without changing the resistances of the circuit we can increase E, and also increase e, while keeping $E-e$ the same as before, it is clear that the heat loss will be precisely the same as before. But how about the work done? Let the two new values be respectively $\acute{E}$ and $\acute{e}$. Then the electric energy expended is—

$$\acute{W} = \frac{\acute{E}\,(\acute{E}-\acute{e})}{\Sigma R}$$

and the useful work done is—

$$\acute{w} = \frac{\acute{e}\,(\acute{E}-\acute{e})}{\Sigma R}$$

That is to say, with the no greater loss in heating, more energy is transmitted, and more work done. Also the efficiency is greater, for

$$\frac{\acute{w}}{\acute{W}} = \frac{\acute{e}}{\acute{E}}$$

and this ratio is more nearly equal to unity than $\frac{e}{E}$ because both E and e have received an increment arithmetically equal. Clearly, then, it is an economy to work at high electromotive force. The importance of this matter, first pointed out by Siemens, and later by Marcel Deprez, cannot be overrated. But how shall we obtain this higher electromotive force? One very simple expedient is that of driving both the generator and motor at higher speeds. Another way is to wind the armatures of both machines with many coils of wire having many turns. This expedient has, however, the effect of putting great resistances into the circuit. This circumstance may, nevertheless, be no great drawback, if there is already a great resistance in the circuit—as, for example, the resistance of many miles of wire through which the power is to be transmitted, in this case, doubling the electromotive force will not double the resistance. Even in the case where the line resistance is insignificant, an economy is effected by raising the electromotive force. For, as may be deduced from the equations, when $E-e$ is kept constant, the effect of doubling the electromotive force is to double the efficiency, when the resistance of the line is very small as compared with that of the machines, and to quadruple it when the resistance of the line is very great as compared with that of the machines. It is, in fact, worth while to put up with the extra resistance, which we cannot avoid, if we try to secure high electro-

motive force by the use of coils of fine wire of many turns. It is true that the useful effect falls off, *cæteris paribus*, as the resistance increases; but this is much more than counterbalanced by the fact that the useful effect increases in proportion to the square of the electromotive force.

In the recent attempt of M. Marcel Deprez to realise these conditions, in the transmission of power from Miesbach to Munich, through a double line of telegraph wire, over a distance of thirty-four miles, very high electromotive forces were actually employed. The machines were two ordinary Gramme dynamos, similar to one another, but their usual low-resistance coils had been replaced by coils of very fine wire. The resistance of each machine was consequently 470 ohms, whilst that of the line was 950 ohms.* The velocity of the generator was 2,100 revolutions per minute; that of the motor, 1,400. The difference of potential at the terminals of the generator was 2,400 volts; at that of the motor, 1,600 volts. According to Professor von Beetz, the President of the Munich Exhibition, where the trial was made, the mechanical efficiency was found to be 32 per cent. M. Deprez has given the rule that the efficiency $\frac{w}{W}$ is obtained, in the case where two identical machines are employed, by comparing the two velocities at the two stations. Or

$$\frac{w}{W} = \frac{n}{N}$$

Where N is the speed of the generator, n that of the motor. There is, however, the objection to this formula, that the electromotive forces are not proportional to the speeds, unless the magnetic fields of the two machines are also equally intense, and the current running through each machine the same. This is not the case if there is leakage along the line. Moreover, when there are resistances in the line, the ratio of the two electromotive forces of the machines is not the same as the ratio of of the two differences of potentials, as measured between the terminals of the machines.

I now turn back from these somewhat abstract questions to consider, by the light we have derived already, some points in the design and construction of motors. We shall find that many of the rules suggested in my former lecture are applicable also to the case of motors, and supply answers to many of the questions that naturally arise.

In the first place, shall we build motors large, or shall we build numbers of small ones? In my first lecture I proved that, in the dynamo used as a generator, the capacity for doing work increased as the fifth power of the linear dimensions; that by doubling a dynamo in length, breadth, and thickness, we had a machine weighing eight times as much, costing less than eight times as much, but capable of doing thirty-two times the work, and that with a great gain in economy in working. The same thing is true of motors. Suppose instead of building eight small motors, we build one large one, of doubled dimensions. It will not cost so much as the eight, will get through four times as much work as the eight put together, and will be more economical in working. I assume here, of course, that the large machine can be placed under equally advantageous conditions of supply.

This is by no means the only one of the points in the theory of the dynamo which can be applied to practice in the cases in which the dynamo is used as a motor. I will give another example.

In the prospect of an immediate field of usefulness opening out for motors, so soon as we have such a thing as regular town supplies of electric currents laid on, it is most important that motors should be designed, not simply to work with the constant electromotive force supplied at the electric mains, but designed also to work at uniform speeds. It is highly important, for example, in driving a lathe, and indeed many kinds of machinery, that the speed should be regular, and that the motor should not "run away" as soon as the stress of the cutting tool is removed. Now, in my second lecture, I spent some time explaining the methods by which M. Marcel Deprez and Professor Perry had solved a converse problem to this, namely, that of getting a dynamo to feed a circuit with currents, at a constant electromotive force, when driven with a uniform speed. The solution to that problem we saw consisted in using certain combinations for the field magnets, which gave an initial magnetic field, independently of the actual current furnished by the dynamo itself. Now, it is not hard to see that this problem may be applied conversely, and that motors may be built with a combination of arrangements for their field-magnets, such that, when supplied with currents at a certain constant electromotive force, their speed shall be con-

* These figures, and those which follow, are given on the authority of the President of the Munich Exhibition, Professor von Beetz. It is but fair to add that M. Deprez is not satisfied of their accuracy.

stant, whatever the work or no work which they may be doing. The one difficulty in the problem—and this is a mere matter for experiment and calculation—is to find the critical number of volts of electromotive force at which this will hold good. It is, in fact, the converse to the operation of finding the critical velocity at which one of Deprez's or of Perry's combination dynamos must be driven, in order that it may give a constant electromotive force. M. Marcel Deprez has, himself, constructed motors upon this plan. Some three years ago, I saw one of Deprez's motors, which ran at a perfectly uniform speed, quite irrespective of the work it was doing. Whether it was lifting a load of five kilogrammes from the ground, or was letting this load run down to the ground, or ran without any load at all, the speed was the same. At the Paris Exposition Electrique of 1881 a large number of Deprez's motors were shown, running at uniform speed and driving various machines, lathes, sewing-machines, &c.

Amongst others who have aimed at producing a motor to work at uniform speed, are Professors Ayrton and Perry. Professor Ayrton informs me that one of these motors, weighing only 350 pounds, will give an effective power equal to 8-horse power, and that "without any mechanical governor; without anything, in fact, in the nature of a moving governor, it always goes at the same speed, whatever work it has to do." Certain little legal matters connected with the protection of this invention have debarred Professor Ayrton from informing me more fully of the new machine, which, if it fulfils the promise of its inventors, will be a great step forward in the mechanical application of electricity. But I can hazard a guess that the arrangement for obtaining uniform speed is dependent on the prior condition that the motor be supplied, either with a constant electromotive force, or with a constant current of a certain "critical" value; and that the solution of the problem is virtually one of the cases of combination, the counterpart of which, as applied to generators, I discussed last week.

It is, of course, possible to use as a motor any direct current dynamo, whether the field-magnets be series-wound, shunt-wound, separately excited, or permanently magnetised. There is this curious point of difference in different cases. Suppose the dynamo to be arranged so as to work as a generator, and then to be supplied with currents from an exterior source, to make it work as a motor. If the dynamo is series-wound, it will run the reverse way (or against its brushes), no matter which way the currents run through it. If the dynamo be shunt-wound, it will run with its brushes, whichever direction the current runs through it. The direction of rotation taken by the separately-excited and the magneto-machine will also be with the brushes, if the current is in the right direction, through the armature. These points have to be taken into account in any attempt to combine the different systems.

If we attempt to apply to motors rules and suggestions, such as these applied to generators in the first of these lectures, we shall find that, whilst some of them apply directly, others are singularly in contrast. For example, we found it advisable, for the sake of steadying the currents in generators, to use large and long field-magnets with plenty of iron, and with heavy pole pieces. In the case of motors, there is no such necessity laid upon us; for we want here to produce a uniform steady rotation. Now, even if the impulses be intermittent, the mechanical inertia of the moving parts will steady the motion. Electric currents have no such inertia (except in so far as the self-induction in a circuit exerts an influence like that of inertia), and hence the precautions for generators. In the case of generators, we found that, to produce steady currents, we had to multiply coils on the armature in many separate paths, grouped round a ring or a drum, involving a complicated winding, and a collecting apparatus, consisting of many segments. In motors no such necessity exists, provided only we arrange the coils that there shall be no dead points. I do not say that, for large motors, it may not be advisable to multiply the paths and segments for other reasons—as, for example, to obviate sparking at the collectors—but, for securing steady running, the inertia of the moving parts spares us—at any rate, in small machines—the complication of parts which was expedient in the generator. Some of the most successful of the little motors that have recently appeared—those, for example, of Deprez, Trouvé, and Griscom—have for their armatures the simple old shuttle-wound Siemens armature of 1856, and in these motors, of course, there is the disadvantage of dead-points to take into account. Deprez, in his first motors, placed this armature longitudinally between the poles of a horse-shoe magnet, with the axis parallel to the limbs. He has also constructed motors with two such armatures on one spindle, one of the coils being

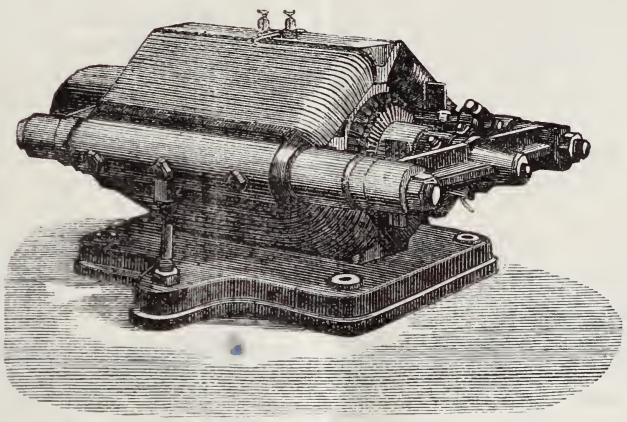
90° in advance of the other, so that while one was at the dead point, the other should be in full action. The same suggestion has been carried out in Akester's motor. Trouvé has tried to get over the dead-points, by utilising the method of oblique approach mentioned earlier in my lecture. The Griscom motor, which has little copper rollers as commutator brushes, has, for field-magnets, a compact tubular electro-magnet wound in series with the armature. It has the disadvantage of dead-points. There is, in all these motors, the disadvantage that at every half-revolution the magnetism of the armature core is reversed; and as in all these forms this core is of solid iron, there must be waste by heating in the cores. In fact, to the rotating armatures of motors, as to those of generators, apply all the rules about slitting to get rid of induced eddy-currents, avoiding idle coils and useless resistances, &c. The rules about proper pole-pieces, adjustable brushes, multiplication of contacts, also are mostly applicable to motors as well as to generators.

In order to meet the case of a handy and reliable motor, I have designed a machine, the smallest size of which is on the table before you. The field-magnets, which also constitute the bed-plate of the motor, are of malleable cast iron, of a form that can be cast in one, or at most two, pieces. The form of them is that of a Joule's magnet, with large pole-pieces, and wound with coils, arranged partly in series, partly as a shunt, in certain proportions, so as to give me a constant velocity when worked with an external electromotive force of a certain number of volts.

As an armature, I employ a form which, I think, unites simplicity with efficiency for the end desired. I do not want dead points, and yet I do not want to have a complicated armature. I have, therefore, modified the old Siemens armature by embedding, as it were, one of these shuttle-shaped coils within another, at right angles to one another. And having duplicated the coils, I must, of course, duplicate the segments of the commutator, which, therefore, becomes either a four-part collector, or else a double collar, according to circumstances. There are no solid iron parts in the armature, but the cores are made of thin pieces of sheet iron, stamped out and strung together. Of the efficiency of this little motor you were witnesses a little while ago, when I employed it in the experiment with the galvanometer.

There are here on the table two other forms of motor, one of which is the design of Mr. A. Reckenzaun, C.E., and which is interesting because its armature, though a drum-armature in form, in reality consists of independent coils, connected, like those of the Brush dynamo, to separate commutators. There are, in fact, four commutators grouped as two twos, and two pairs of brushes in contact with them.

Fig. 61.



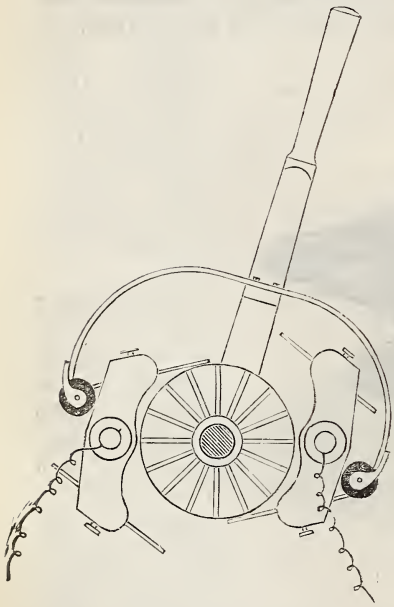
The De Meritens Motor.

The other motor (Fig. 61) is one of the pattern invented by De Meritens, who employs a ring-armature very like that of Gramme, but places it between very compact and light field-magnets, which form a framework to the machine. There is one point about this machine of great interest, which is, however, a later addition. It is provided with a reversing gear, which, when I move the handle, reverses the direction in which it runs. This gear, which is the invention of Mr. Reckenzaun (to whom I am indebted for the loan of this motor) is shown in Fig. 62 (p. 172). In it there are two pairs of brushes; the two upper are fixed to a common brush-holder, which turns on a pivot, and can be tilted by pressing a lever handle to right or to left. The two lower brushes are also fixed to a holder. Against each brush-holder presses a little ebonite roller, at the end of a bent steel spring, fixed at its middle to the handle. The result of this arrangement is that, by moving the lever, the brushes can be

made to give a lead in either direction, and so starting the motor rotating in either direction. Such a reversing gear is obviously a most essential adjunct for industrial applications of motors, and, if the difficulties of sparking at the brushes, caused by the sudden removals of them from the collector, be obviated, must prove much better than any mechanical device to reverse the motion, by transferring it from the axle of the motor through a train of gearing to some other axle. One great advantage of electric motors is, that they can be so easily fixed directly on the spindle of the machine they are to drive; an advantage not lightly to be thrown away.

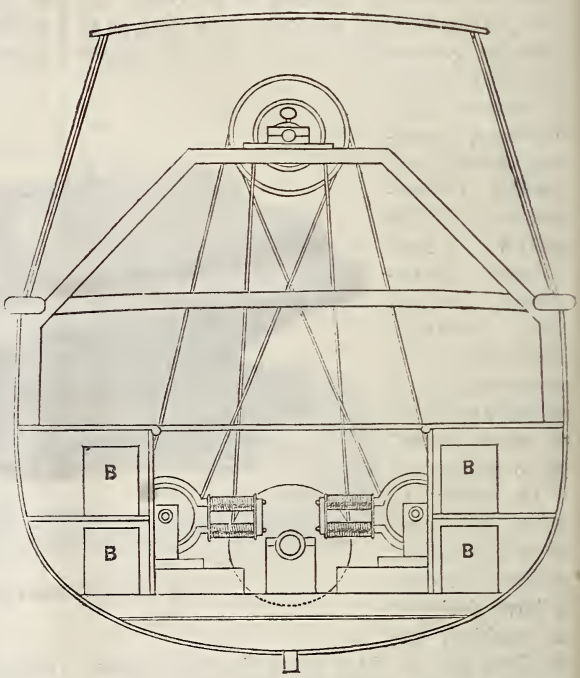
There is, indeed, an immense field for useful industrial application of electric motors, so soon as we once have at our disposal regular town-supplies of electric currents. Already we have got the little motors of Griscom, Howe, and others, adapted to work sewing-machines, and instruments requiring very small power. Larger motors, for driving lathes and heavier machinery, though not yet much known to the public, are in the market. Messrs. Siemens have brought out an electric

Fig. 62.



Reckenzaun's Reversing Gear.

Fig. 63.



Machinery of the Launch "Electricity."

lift or elevator,* in which a small dynamo, itself running very quickly, drives an endless screw, and communicates a slow, but powerful, motion to a drum, on which the hauling chain is wound. If town-supplies of electricity were accomplished facts, such lifts would be multiplied. Indeed, there are very many purposes for which hydraulic power is used, for which electric power might be advantageously substituted. The electric railway, dimly foreshadowed by George Little, in 1844, when he patented an "electro-locomotive," has become an established fact. From the electric railway first established in Berlin, in 1880, by Siemens and Halske, we already have had the further developments of the electric tramway in Paris, and the experimental electric railway at the Crystal Palace. Edison has constructed an electric railway at Menlo-park, and built electric locomotives to ply upon it. Nor must I omit to mention how, in the bleaching fields of France, an electric tramway does most

* Dr. Hopkinson has also invented an electric lift, in which the armature of the motor, running at a high speed, works the chain of the lift by a train of toothed wheels, which reduce the speed. This elevator was shown in operation at the Paris Exposition of 1881.

satisfactory duty; nor how, finally, in the sister isle, at the Giant's Causeway, Messrs. Siemens Brothers have established a line of electric railway, which is now actually in operation.

Latest of all the applications of the dynamo as a motor is that of electric navigation. Jacobi, as we know, fitted up, in 1838, an electric paddle-boat, which he propelled on the Neva, first with Daniell's and afterwards with Grove's cells, and was even able, when he used 128 large cells, to carry fourteen persons against the stream, at a speed of about $1\frac{1}{4}$ miles per hour.

M. Trouvé, of Paris, was the next to apply electric power, in the shape of Planté's accumulators, to a pleasure-boat, with which he navigated the Seine. But M. Trouvé has more recently abandoned storage cells, and has returned to the use of a bichromate battery, wherewith to drive the little boats, which he fits up with his little motors, mounted upon the top of the rudder, and turning a light screw-propeller by a driving belt, which passes down behind the rudder into the water.

Still more recent is the electric launch which made its trial trip on the Thames,* last September. This is an iron boat twenty-five feet long, fitted with a screw, and able to carry twelve persons, while running against the tide, at a pace of eight miles an hour. No existing motor of requisite power having yet been made of a form convenient to place directly upon the axis of the propeller, the expedient has, in this case, been resorted to of driving the screw by belts from an overhead counter-shaft, which receives its motion from two small Siemens' dynamos placed below. The arrangements of the machinery of the boat are depicted in Fig. 63 (p. 172). Each of these dynamos has been provided by Mr. Reckenzaun, who designed the fittings of the launch, with reversing gear like that shown in Fig. 62, p. 172. The current, which actuates these dynamos, is derived from forty-five accumulators of the Sellon-Volckmar type, which are charged while the launch lies at its moorings. Though this is a great step in electric navigation, I venture to believe that it is yet but a beginning of greater things. As with steam-boats so with electric-boats, we shall find that we begin with small experimental attempts, and increase in size as experience dictates. It is but a few days since I was reading, in an old volume of the *Philosophical Magazine* for the year 1801, of Symington's early little steamboat—the forerunner both of Fulton's and of Bell's — and the writer of the article hardly dared to think of this as more than an ingenious experiment, and doubted whether large vessels could ever be practically driven by steam. When I read this curious narrative, I bethought me of the trial trip of the little launch *Electricity*, and began to think that I was not so very hopelessly wrong, when I wrote in September last, "Who shall say to what proportions this latest application may not attain in the next decade?"* Could we look forward, and see with our eyes to-night the electric boats of fifty years hence, we should not, perhaps, be more surprised than those who beheld the first rude steamboat would be, if they could now rise from their graves to behold the great ocean-going steamships of to-day. Indeed, when I look around, and see so many opportunities for the future application of electric motive power, so many instances in which the dynamo would supply a welcome and economical †

* In 1856, Mr. G. E. Dering constructed, at Messrs. Searle's, an electric boat worked by a motor, in which the rotation was effected by magnets arranged within coils, like galvanometer needles, and acted on successively by currents from a battery. It succeeded, I am informed, in making headway, though at small speed, against the tide at its swiftest.

* It is well known that a no less authority than Dr. Lardner publicly pronounced it impossible for any steamboat ever to carry coals enough to enable her to cross the Atlantic. It is also recorded that a very eminent public man offered to swallow the boilers of the first steamboat that should succeed in crossing the Atlantic. But he would be a bold man who would now-a-days promise to swallow the accumulators or the dynamos of the first electric boat that shall successfully make the same trip across the water.

† As to the economy of electric motive power, I may perhaps be allowed to quote a passage from a recent lecture of my own in Bristol, in which a concrete case is presented:— "When it is possible thus to obtain power by merely turning on a tap, there will be an enormous impetus to all kinds of small machinery. Motors to work sewing-machines already exist, and would be used literally by millions if the source of electricity were but at hand, in the form of a friendly wire always ready to bring the needed power. . . . . Again, the establishment of a town supply of electricity will tend unquestionably to develop the industries of small workshops and home workshops, where a little power is required. I have already explained how, with steam power, small engines of one horse-power or less are uneconomical. But with electricity it is not so. The smallest electro-motors may be made just as economical as are the largest. There is, moreover, another point in their favour. They may be made far smaller, lighter, more compact, and far cheaper than steam-engines of corresponding power. . . . . It is certainly possible to construct an electric motor of two horse-power for ten pounds, and such a motor would be ample for the purposes of many small workshops. Why do we not, it may be asked, hear and see more of these little machines, if they are so excellent? Why do not people adopt them? The answer is simply they cannot be used until we have a central supply of electricity. I do not hesitate to affirm that such motors will be found to present an enormous economy in com-

means of doing that which is now done by less advantageous means, I begin to wonder why we do not establish central supplies of electric currents for this purpose, which is surely as important as electric lighting. Here we have the possibility of introducing machinery that is portable and light, giving us power without the inconveniences and risks hitherto attending the employment of power. Surely there must be many workshops in every town where the owner would be glad of having power without the trouble and danger of a furnace, boiler, and steam-engine, or even of a gas-engine, in his place; where a boiler cannot be put for want of space, and where a steam-pipe cannot be carried because of the inevitable condensation. So thoroughly am I convinced of the great future that lies before dynamo-electric machinery, from this point of view, that I am disposed to think electric lighting a very small item by comparison.* When once we get a proper system arranged for the general distribution of electric currents in a regular town supply, we shall begin to realise the hundreds of ways, as yet undreamed of, in which electricity may be utilised to meet our wants, and to subserve the ends of civilisation.

parison with steam-engines of equal power. Take the case of a small workshop which wants just two horse-power to turn a few lathes or drilling machines. A small steam-engine and boiler will, together, cost about £70, and the consumption of coal will be about 13 lb. weight per hour. Instead of this, put in a motor costing, let us say, £20, which allows for handsome profits on manufacture. Here is a saving in capital outlay at once. Moreover, the motor may be put right into the workshop, for it is small—perhaps two feet long, eighteen inches broad, and one foot high—and is not liable to leak or explode. The next point to consider is the cost of running it. Let us suppose that it has only an efficiency of 70 per cent., or that it only turns 7-10ths of the energy of the current into useful mechanical work. (Many motors will do far more than this.) Let us also suppose that the currents are furnished by a dynamo whose efficiency is 90 per cent. (which figure is also capable of being attained in practice), worked by a large central steam-engine, consuming only 1½ lb. of coal per horse-power. Allow 4 per cent. for loss, by resistance, in the conducting cables; this reduces the total efficiency of the generator to 86 per cent., and of that 86 per cent. only 7-10ths—*i.e.*, 60·2 per cent.—is eventually converted back into useful work by the motor. We have, then, 40 per cent. wasted in order to get 60 per cent. of useful work. How does this affect the coal consumption for two horse-power? At the central station 3 lb. of coal per hour would suffice were there no loss in conversion into electric energy, and back again into mechanical power. As it is, 5 lb. of coal per horse-power will be needed, 3 lb. of which represent the 60 per cent. of useful power transmitted, and 2 lb. to represent the 40 per cent. wasted. In practice, I believe, a far less margin of waste might be looked for. Yet even with this large waste there is still an immense economy effected, for we get our two horse-power by an expenditure of 5 lb. of coal at the central station, instead of 13 lb. of coal in the furnace of a small steam-engine. It is clear, then, that electricity offers an enormous future to small motor machinery."

* What is the proportion of coal used for the manufacture of gas in Great Britain, compared with the amount consumed in procuring motive power The answer to this query amply justifies my view.

Notes on Books.

ELECTRIC ILLUMINATION. Edited by James Dredge. London: *Engineering* Office.

The important position that electric lighting is now taking as a branch of civil engineering, is shown by the amount of space given to this subject in the columns of those journals which devote themselves entirely to engineering topics. Not only are there several newspapers confined entirely to matters connected with electricity, but papers such as *Engineering* and *The Engineer* have now a large portion of their space occupied by the discussion of various electrical matters. For some years past, in fact ever since the question of electric lighting came into prominence, *Engineering* has made a speciality of the subject, and week by week it has published articles giving the earliest information, and enabling its readers to estimate accurately the progress of invention in this direction. The proprietors of this newspaper have now made a selection from these articles, and have republished them in the form of a large quarto volume, together with certain additions. How far the material contained in the volume is new, and how far it is a republication, it is hardly possible to say, without a search into the files of *Engineering*; but Mr. Dredge, the editor, on his title-page, speaks of the book as "chiefly compiled from *Engineering*;" and there is, at all events, internal evidence that many of the articles have been brought down to date. Among the authors whose co-operation Mr. Dredge acknowledges in his preface, are mentioned Mr. Conrad Cooke, Prof. Silvanus Thompson, Mr. Vivarez, Mr. O'Reilly, Mr. Munro, and Mr. Raworth. The principal object of the work appears to be to give an account of the various apparatus which has been used, or has been proposed to be used, for the purposes of electric lighting, from the days of the earlier workers in this direction, down to the present time. The volume is apparently the first of a series, and, it is announced, is intended to be followed by a second, dealing with applications of the electric light, and with cognate subjects, such as the cost of production and maintenance, photometry, secondary batteries, &c. The work is divided into four sections. The first section deals with electric units, the measurement of electrical intensity, a short chapter on a subject which, perhaps, will be more fully treated in the coming volume, the voltaic arc; the theory of the mechanical production of electric currents, and the theory of dynamo-electric generators. The second section is devoted

to magnets and dynamo-electric generators. Under this head, accounts of various machines are comprised, from the machines of Pixii, Saxton, Clarke, and Page, down to those of which we hear so much at the present time. Section 3 treats of conductors and carbons. Under the latter head, we have not only an account of the recent inventions connected with the manufacture of carbons, but of the earlier efforts in this direction. The fourth section deals with lamps; arc, incandescence, incandescence-arc, and "candle," especially full accounts being given of the Jablochkoff candle in its early and present forms. An account of an early magneto-electric generator, by Mons. Worms de Romilly, is given in an appendix, it having apparently attracted attention too late for its insertion in the proper place. This machine was patented in France, in 1866, and, according to Mr. Dredge, its specification contains the first intimation of much that has been done by subsequent inventors. Another appendix contains abstracts of specifications of British patents relating to electric lighting, down to 1872, prepared by Mr. Lloyd Wise. Abridgments of nearly all the specifications have already been published by the Patent-office, in the series of abridgments relating to electricity; but Mr. Wise's abstracts are shorter than the official abridgments, and only those portions of the inventions are treated which relate to electric lighting. They have the further advantage of occasional illustration. How far Mr. Wise's list is more complete than the official one it would be impossible to say, without a minute examination of the two. Curiously enough, in the official abridgment of the first patent in which electric lighting seems to be mentioned—that of Pinkus, in 1840—no notice of this fact appears. He proposed to use the electric "glow," or brush, for the purpose; and, so far as can be judged from the specification, what he intended was to drive an electro-magnetic machine from a battery, and to cause that machine to drive a frictional machine for the production of the sparks or the brush discharge. He does not, however, describe any apparatus for the purpose, and there can hardly be any question that this was only one of those vague proposals sometimes found in old patents, and the outcome generally of insufficient knowledge on the part of the inventor. It should be added that the book is copiously illustrated with cuts from the pages of *Engineering*.

General Notes.

Austrian Beer Exhibition.—An international exhibition of products and apparatus connected with brewing, is announced to open in September, at Saaz, in Bohemia, one of the principal hop-markets of Europe.

Royal Institution.—Prof. W. C. Williamson will begin a course of five lectures on "The Primæval Ancestors of Existing Vegetation, and their bearing on the Doctrine of Evolution," on Tuesday next (January 16); Professor Dewar will begin a course of nine lectures on "The Spectroscope and its Applications," on Thursday, January 18; Mr. R. Bosworth Smith, at the Friday evening meeting, January 19, will give a discourse on "The Early Life of Lord Lawrence in India," and will begin a course of four lectures on "Episodes in the Life of Lord Lawrence," on Saturday, January 20.

Turners' Company.—At a meeting of the Court of the Turners' Company, held on Thursday, 11th inst., the freedom of the City and the livery of the Company were presented to Dr. C. W. Siemens, F.R.S., Chairman of the Society's Council, and to Dr. Percy, F.R.S.

The Society's Patent Bill.—The following resolution will be submitted to the annual meeting of the Association of Chambers of Commerce, to be held the end of next month. It is put forward by the Dublin Chamber, and will be introduced by Mr. J. R. Wigham:—"That inasmuch as the present Patent-laws are unsatisfactory and discouraging to inventors, and ought to be amended, the Executive Council be urged to continue their efforts to obtain the enactment of a measure for the amendment of these laws, having for its principal object the simplification of formalities and the reduction of the fees for obtaining Letters Patent; and that, as the Bill promoted by the Society of Arts embodies to a large extent the opinions of this Association on this subject, expressed on various occasions, the Executive Council be requested to watch its progress in the House, as well as any other Bills which may be introduced on the subject, communicating from time to time with the Chambers, should occasion arise for action on their part."

The Woollen Industry of Belgium.—The report of the Verviers Chamber of Commerce for 1881 furnishes some details respecting the development of Antwerp as a wool market, and the progress of the combed wool industry in the neighbourhood of Verviers. The particular feature of interest affecting the first-named subject is the commencement of sales of Australian wool at Antwerp, this branch of import having, up to a recent date, been practically monopolised by London. Combed wool has hitherto been imported into Belgium upon a scale of relative importance, but efforts are now being made at Verviers to render Belgium independent of other nations for the needful supplies of combed wool. Carded wool has long been known as an important product of Verviers industry, and the increase of this trade is shown by the fact that the deliveries for 1880 amounted to 7,800 tons, while those for 1881 were 9,300 tons. The development of the manufacturing industry of Verviers has, to some extent, been injuriously

affected by the relative scarcity of weavers, the prompt execution of shipping orders being thus a difficulty which it has not been easy to surmount. The Chamber of Commerce has given much attention to the increased power-loom weaving, and the utility of special establishments for the carrying out of certain industrial operations.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock :—

JANUARY 17.—"The Sanitary Inspection of Houses." By W. K. BURTON. LORD ALFRED S. CHURCHILL will preside.

JANUARY 24.—"The Suez Canal." By GENERAL RUNDELL.

JANUARY 31.—"Ensilage and Silo." By Prof. J. E. THOROLD ROGERS.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at 8 o'clock :—

JANUARY 30.—"Life among the Turcoman Nomads." By EDMOND O'DONOVAN.

APPLIED CHEMISTRY AND PHYSICS SECTION

Thursday evenings at Eight o'clock :—

JANUARY 25.—"Technical Aspects of Lignification." By C. F. CROSS, F.C.S. Prof. H. E. ARMSTRONG, F.R.S., will preside.

CANTOR LECTURES.

Monday evenings at Eight o'clock :—

Second Course, on "Solid and Liquid Illuminating Agents." By LEOPOLD FIELD.

January 29; February 5, 12, 19, 26; March 5.

The syllabus will be printed be printed in next week's *Journal*.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 15...East India Association, Pall Mall Restaurant, 14, Regent-street, W., 5 p.m. Mr. W. Martin Wood, "Indian Public Works' Finance, Exchanges, and Loans."

Society of Engineers, 6, Westminster-chambers, S.W., 7½ p.m. Mr. A. T. Walmisley, "Land Surveying and Levelling." (Lecture II.)

Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. A. D. Clarke, "Modern Farm Homesteads."

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Col. J. U. Bateman Champain, "Commercial Routes between Central Persia and the Sea."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Paper by Prof. G. G. Stokes.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. James Cotton, "The Races of India."

Law Amendment Society, 1, Adam-street, Adelphi, W.C., 8 p.m. Mr. H. N. Mozley, "The Law Relating to the Custody of Children."

TUESDAY, JAN. 16...Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. C. Williamson, "The Primæval Ancestors of Existing Vegetation, and their bearing on the Doctrine of Evolution." (Lecture I.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. William Anderson, "The Antwerp Water Works."

Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Major Patrick G. Craigie, "Statistics of Agricultural Production."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Lieut.-Colonel H. H. Godwin-Austen, "Freshwater Shells from Socotra." 2. Prof. Ray Lankester, "The Right Cardiac Valves of *Echidna* and *Ornithorhynchus*." 3. Mr. F. Moore, "Descriptions of New Genera and Species of Asiatic Lepidoptera Heterocera."

WEDNESDAY, JAN. 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. K. Burton, "The Sanitary Inspection of Houses."

Meteorological, 25, Great George-street, S.W., 7 p.m. Annual General Meeting. Address by the President.

Entomological, 11, Chandos-street, W., 7 p.m. Annual General Meeting.

Public Analysts, Burlington-house, W., 5 p.m. 1. Mr. O. Hehner, "The Analysis of Wax." (Part I.—Yellow Wax.) 2. Mr. O. Hehner, and Mr. H. S. Carpenter, "Analysis of Sulphocarbonates."

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. W. de Gray Birch, "A Roll in the British Museum." 2. Don Claudio de Bontelow, "An Ancient Spanish Carving of the Madonna."

THURSDAY, Jan. 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Mr. Charles F. Cross, "The Technical Aspects of Lignification."

Linnean, Burlington-house, W., 8 p.m. 1. Mr. S. G. Shattock, "The Fall of Branchlets in the Aspen." 2. Mr. A. G. Bourne, "Certain Points in the Anatomy of *Polynöe clava*." 3. Professor P. M. Duncan, "The Internal Hard Parts of the Fungidæ." 4. Mr. G. J. Romanes, "Observations on the Physiology of the Eclimoderms."

Chemical, Burlington-house, W., 8 p.m. Professor R. P. Plimpton and Mr. E. Graves, "A New Method of Estimating the Halogens in Volatile Organic Compounds."

London Institution, Finsbury-circus, E.C., 7 p.m., Prof. Henry Morley, "English War Poetry."

Royal Institution, Albermarle-street, W., 3 p.m. Professor Dewar, "The Spectroscope and its Applications."

Royal Historical, 22, Albemarle-street, W., 8 p.m.

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Philosophical Club, Willis's-rooms, St. James's, S.W., 6½. p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. H. T. Munday, "The Process for Obtaining Sanction for Public Works."

Society of Telegraph Engineers and of Electricians, 25, Great George-street, S.W., 8 p.m. Inaugural Address by the President, Mr. Willoughby Smith.

FRIDAY, JAN. 19...Royal Institution, Albemarle street, W., 8. p.m. Weekly Meeting. 9 p.m. Mr. R. Bosworth Smith, "The Early Life of Lord Lawrence in India."

Philological, University College, W.C., 8 p.m.

SATURDAY, JAN. 20...Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. Bosworth Smith, "Episodes in the Life of Lord Lawrence." (Lecture I.)

Journal of the Society of Arts.

No. 1,574. Vol. XXXI.

FRIDAY, JANUARY 19, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

SOCIETY OF ARTS' PATENT BILL.

The Council have determined again to bring before Parliament the Bill for the reform of the Patent Law, prepared by a Committee of the Society, and read a second time in the House of Commons last year..

Sir John Lubbock, Bart., F.R.S., has consented to introduce the Bill to the House of Commons at the commencement of the ensuing Session, and the Right Hon. W. H. Smith and Mr. Compton Lawrance, Q.C., will allow their names to appear on the back of the Bill as before.

The Bill, as introduced, will be exactly the same as that of last year.

LABELS FOR PLANTS.

The Council of the Society of Arts offer a Prize of Five Guineas, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for a Wooden Plant Label, saturated with paraffin, or some other preparation which would preserve the label, and would be likely to keep the writing upon it legible, either with or without the aid of paint, for five years. The labels will be tested by the Committee with the view of ascertaining, as far as can be done in a limited time, whether they would be likely to stand prolonged use. It is believed that satisfactory tests can be made in a month or two.

An additional Prize of Five Guineas has been placed at the disposal of the Council of the Society by Mr E. G. Loder, for the best permanent Border Label suitable for private gardens, the cost of which should not exceed £4 per thousand.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society not later than the 1st June, 1883.

Both awards will be made on the recommendation of the Committee appointed for the purpose by the Council.

The Council reserve to themselves the right of withholding the prizes offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

UNION OF INSTITUTIONS.

The following Institution has been received into union since the last annonncement :—

Aberdeen—Robert Gordon's College.

Proceedings of the Society.

SEVENTH ORDINARY MEETING.

Wednesday, January 17, 1883; Captain Douglas Galton, C.B., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society :—

Bailey-Denton, Eardley F., 22, Whitehall-place, S.W.

Belfield, Reginald, Llyndally, 1, Palace-road, Streatham-hill, S.W., and Phœnix Electric Light Company, 4, George-street, Hanover-square, W.

Blyth, Philip T., 17, Gracechurch-street, E.C.

Brown, John, 23, Whitefriars-street, E.C.

Bruce, Gainsford, 2, Harcourt-buildings, Temple E.C.

Clark, William Henry, Merton Abbey, Merton, Surrey.

Clutton, William James, The Mount, York.

Cruickshank, Arthur B., The Grand Hotel, Charing-cross, S.W.

Dash, Thomas Alexis, The Hollies, Feltham, Middlesex.

Goulden, Thomas, 55, Milbank-street, S.W.

Gray, William Lewis, 36, Gutter-lane, E.C.

Henderson, Alexander Lamont, 277, Lewisham-road, S.E.

Isaac, Leon Joseph, 10, Adelphi-terrace, Strand, W.C.

Jonas, Joseph, Continental Steel Works, Sheffield.

Lindley, Joseph, Blittersdorffs Platz, 29, Frankfort-on-Main.

Lloyd, David, 15, Motcomb-st., Belgrave-sq., S.W.
Medhurst, John Thomas, 124, Narrow-street, Limehouse, E.
Moon, William, 67, Moray-road, Tollington-pk., N.
Morgan, James Henry, 124, Narrow-street, Limehouse, E.
Phillips, William Alfred, Electrical Works, Wharf-road, Hackney-wick, E.
Powell, Miss, Ottawa-lodge, Guildford, Surrey.
Roe, James Elphinstone, Margan-lodge, Fulham-park, S.W.
Sim, Lieut.-Colonel Edward Coysgarne, R.E., 32, James-street, Buckingham-gate, S.W., and Shorncliffe.
Turner, Walter William, 31, Malpas-road, Brockley, S.E.

The following candidates were balloted for and duly elected members of the Society:—

Allan, Alexander, Netley-court, near Southampton.
Cooke, Major-General Anthony Charles, C.B., Ordnance-house, Southampton.
Fearfield, John Piggin, Brook Hill-house, Stapleford, Notts.
Goodman, Henry Martin, Avalon, Catford Hill, Catford, Kent.
Harris, John, Clifton-house, Kilburn-square, N.W.
Joel, Henry Francis, 44, Lavender-grove, Dalston, F.
Liberty, Arthur Lasenby, 7, Fairfax-road, Finchley-road, N.W.
Perks, Robert William, Calverley, Chislehurst, and 147, Leadenhall-street, E.C.
Turner, H., 51, Bury New-road, Manchester.

The paper read was—

SANITARY INSPECTION OF HOUSES.

By W. K. Burton.

In reading a paper before you on the subject of sanitary inspection of houses, I do not wish it to be thought that I am going to describe any new system, or to enunciate any new theory with regard to the great question of drainage. What I wish to do, is principally to try to give an idea of what is the condition as regards efficiency or the reverse of the drainage arrangements at present existing in the average London house.

In January of 1881, Professor Fleeming Jenkin, F.R.S., read before you a paper, in which he briefly described the objects to be arrived at in draining houses, and pointed out what he considered the best means of enabling individual householders to have these objects carried out. It is the result of work based upon the system then recommended that I shall use to illustrate my paper to-night. Since Professor Jenkin read his paper, 523 houses have been inspected by the association with which I have been connected. The results of these inspections have been tabulated, and defects discovered have been reduced to per-centages. The number is such that the per-centages may be considered to apply with fair accuracy to all houses of the same class in London; and here, at the outset, I wish to impress on you the fact that the class of houses, the defects of which we are to consider, is the very best in London.

I do not propose to enter at all into the subject of rival sewerage systems, nor into the class of evils which arise from breathing air from sewers. I wish, however, to point out that where, as in London, the sewerage system is fairly good, dangers to health arise not from the sewers direct, but either from the sewers by means of the house drains, or even more often from the house drains themselves. It is quite agreed by medical authorities that diseases may arise from gases evolved from the drains, or even discharge-pipes in a house, entirely apart from any specific infection such as may be conveyed by means of sewers.

This being the case, it will be seen that the thing which most behoves us is to make sure that the house system is doing efficiently its work. It is evident that the objects to be aimed at in constructing a system of house drainage, are as follows:—

First. All matter placed in any of the sanitary appliances in the house must be carried, with the greatest possible expedition, clear of the premises, leaving behind it as little deposit as possible.

Second. All sewer air must be prevented from entering the houses by the channels which serve to carry away the sewage.

Third. Since it is impossible to have house drains absolutely clean, that is, devoid of all decomposing matter, all air from house drains, and even from sink, bath, and other waste-pipes must be kept out of the dwelling-rooms.

To which might be added a fourth, that a constant current of fresh air must be established along every pipe in which it is possible that any decomposing matter may remain, so that such matter may be rapidly oxidised, or rendered innocuous.

The number of houses in which we find the drainage arrangements to be thoroughly good, and to be fulfilling these conditions, is surprisingly small. In fact, I may say, that in all the houses we are called upon to examine, except those which have been arranged, within the last dozen years or so, by some engineer, builder, or plumber who has made a special

study of the matter, we find defects which interfere with the due fulfillment of one or other of these conditions.

I beg leave to call your attention to a drawing which I have here (Fig. 1, p. 180), in which the drainage arrangements are shown to be defective. I have taken such a state of affairs as is by no means uncommon in a London house. I might, by taking separate defects, which I have seen in separate houses, have shown things infinitely worse than I have, but I wished to avoid anything of a "sensational" character. I would, therefore, have you understand that what is here exhibited is something such as is quite commonly discovered in a London house. I have seen individual houses in which the drainage is more defective. In fact, I should describe the house illustrated now as somewhat below the average of the better class London house, as regards drainage arrangements.

I have alongside of it a drawing which illustrates a well-drained house (Fig. 1, p. 180). I do not propose elaborately to describe the latter, as my object is rather to point out where defects are to be found than otherwise; but, by its juxtaposition with the first drawing, the defects exhibited in the latter will be made more patent.

The first point to which I wish to draw your attention is the condition of the main drain. It will be seen that it is little other than an elongated cesspool. The size is unnecessarily large. As a consequence, even if it were perfect in all other respects, it would not be self-cleansing, inasmuch as there can never pass down the drain which serves for a single house enough water to scour out pipes of the size illustrated, namely, 9 in. diameter.

It will be seen, however, that the state of affairs is far from correct, apart from the size of the pipes. In the first place, the joints are not tight; sewage will soak out into the ground through them. In the second place, although there is ample allowance between the two ends of the drain for a good fall, or incline, this fall has all been confined to a few feet of its length, the part underneath the house being laid almost level. This is done simply to avoid the trouble of excavating the ground to a sufficient depth.

Let us now follow the action of a drain of this kind, and see what it will lead to. Sewage matter finds its way into it. As we all know, this matter depends on water to carry it forward. It is probable that, while the drain is new and the ground comparatively solid around it, sufficient water will remain in it to carry the greater part of the sewage to the sewer. But this state of affairs will not last. Before long, some unusually heavy or obstinate matter will get into the drain. It will be carried only so far, and will then stick. Any water now coming behind it will "back up," to a certain extent, and will very soon find its way into the soil, from one or more points behind the obstruction—not yet amounting to a stoppage. As a consequence, sewage now passing into the drain, loses its carrying power, and gets no farther than a certain distance. Before long, a complete stoppage takes place, and all the sewage of the house soaks into the ground under the basement. After this, things go from bad to worse. The saturated ground no longer properly supports the pipes, which, as a consequence, will become more and more irregular, and all hope of the drain clearing itself is lost. It is only a question of time, with a drain such as I have shown, and the inmates of the house will be living over a cesspool.

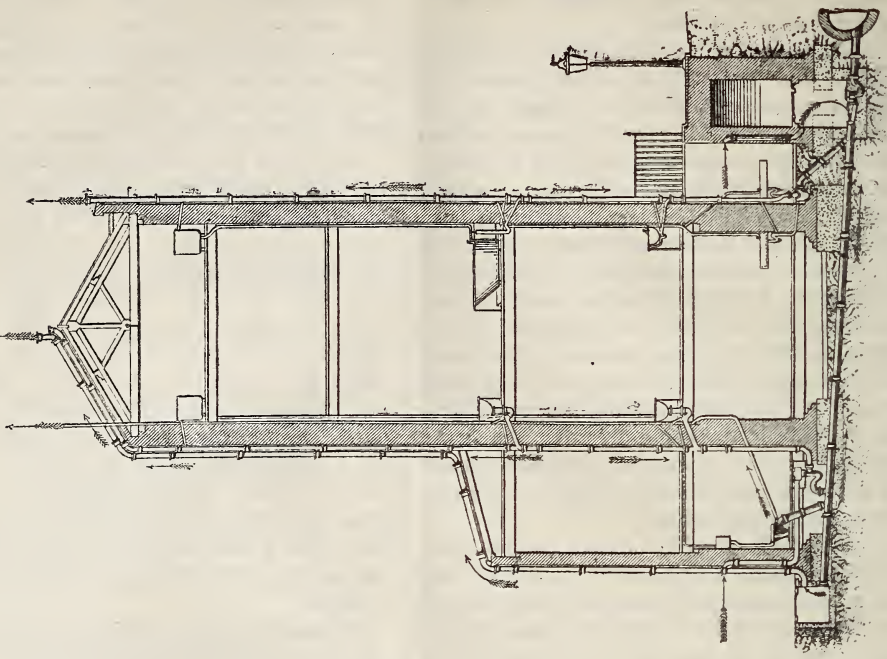
As a matter of fact, total obstruction or stoppage has been discovered in 6 per cent. of the houses which we have inspected.

The next point worthy of attention is the soil-pipe; this term being at present used to signify the vertical portion of the drain only, although it very often is also used as meaning the almost horizontal drain under the house.

It will be seen that the soil-pipe is of lead. This is an excellent material if the pipe be properly arranged, but here it is not. The great fault is that there is no ventilation. As a consequence, the upper part of the pipe will always be filled with sewer gas, which tends to rise in a somewhat concentrated state. Now, sewer gas has a powerful action on lead, and, therefore, a soil-pipe arranged without ventilation never stands many years before it becomes "holed," that is to say, is worn through at its upper part. When this occurs, of course there is ventilation enough, but it is into the house. The ventilation in this case will, in fact, be most active, because every house, on account of the fires in it, acts, especially in winter, as a chimney, and draws in sewer or other gas from every possible crevice.

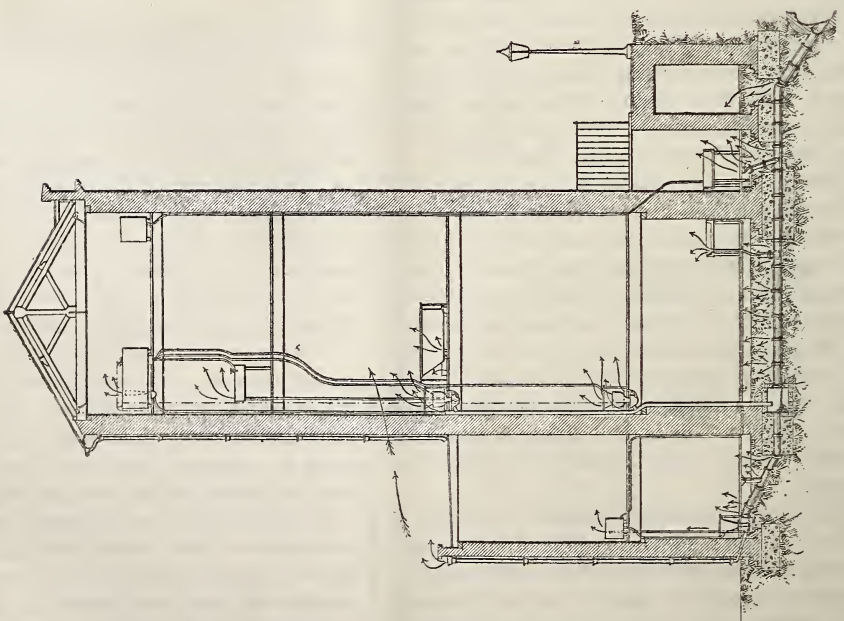
At the top of the soil-pipe will be found the commonest of all water-closet arrangements, namely, the pan-closet with D trap. I shall not describe this arrangement in detail; it is exceedingly well known. I may merely say, that it is a most skilfully devised piece of

FIG. 2.



WELL-ARRANGED HOUSE.

FIG. 1.



DEFECTIVE ARRANGEMENT.

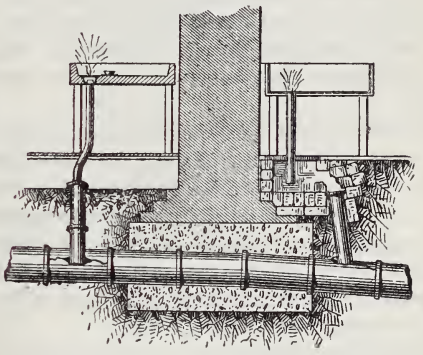
apparatus for retaining sewage in the house, and distilling sewer gas from the same, and that it is the cause of probably nine out of ten of the actual smells perceived in houses, even if it does not (as some say) give rise to much actual disease.

The soil-pipe discharges over a small cesspool at the foot. This is a very common arrangement. The cesspool is usually dignified by the name of a dip trap. The per-centage of houses showing leaky soil-pipes is thirty-one.

Now, observe that, although our constructor has not ventilated his soil-pipe, he has been careful not to leave the system entirely without ventilation. On the contrary, by the simple device of leaving a rain-water pipe untrapped at the foot, he has ventilated the drains, and also the public sewer, into the back bedroom windows! This is a quite common arrangement. I have, within the last two months, seen two cases in which it has resulted in typhoid fever. In each case, children slept in rooms, the windows of which were within a few feet of the upper ends of rain-water pipes, left untrapped, either through carelessness or through the idea that they would be useful as ventilators.

Next, in order, we may take the case of the discharge-pipes from baths, sinks, basins, and all such appliances. It has been laid down as a rule by the best sanitary authorities that these appliances must discharge not into the soil drains, but into the open air over trapped gullies, as it has been found that this is the only way of being absolutely certain that no sewer air shall enter the rooms by the discharge-pipes. It is quite true that if a trap be fixed on the discharge-pipe of, say, a sink, the greater part of the sewer air may be kept back from the house; but traps, however excellent they may be in *assisting* to keep out sewer air, are not alone sufficient. There are several reasons for this. In the first place, there is the fact that a certain amount of sewer gas will pass through the water of a trap, or, to speak more strictly, will be absorbed by the water on one side, and afterwards given off on the other side. It is true that in the case of a well-ventilated drain this amount will be infinitesimal, and might even be disregarded, but there are other causes for the uncertainty of a trap. If the appliance on the discharge-pipe of which it is be disused for a long time, there is the possibility that the water in the trap may dry. In this case, of course, there is no further security. Besides this, however, there is an action known as syphonage, in which the rush of water through a pipe carries with it the water which ought to remain in the trap and form a seal. In the drawing there are shown several different ways of connecting sinks, &c., with drains. In a separate drawing (Fig. 3) there is shown on a larger scale, so as to make it more distinct, a portion of the drain with two sinks discharging into it. In the one case, there is on the discharge-pipe an apology for a trap, in the form of a little apparatus called a bell trap. I have such a thing on the table, and you will readily be able to see that, at the best, the security afforded by it is but slight. But, as a matter of fact, it is the commonest thing possible to find the bell trap in the position shown in the drawing—that is, lying on the sink. It has been lifted out of its place to let the water run down the waste-pipe

Fig. 3.



Detail of Sinks in Fig. 1.

more quickly. It is no unusual thing to go into the scullery of a house, and to find the discharge-pipe of the sink quite open, as is shown, and a blast of sewer air issuing from it which will extinguish a candle.

In the case of the other sink there is shown an arrangement which is called a grease trap, but is, in reality, nothing more nor less than a particularly foul cesspool. It calls for little remark. You will see that the pipe from the sink dips into the foul water to make a trap. In many cases, the pipe does not dip into the water; but there is a bell at the top, as shown in the case of the other sink. On three occasions, when I have lifted the bell from such an arrangement, and applied a match, the foul gas has actually caught fire, burning with a blue lambent flame. It will be noticed in this drawing that the

drain is at various places made up with bricks. This is a very common thing to find in houses. The bricks are used to save the trouble of getting special junction bends, &c. The other sinks and baths in the house are shown as discharging into the closet traps. This is a very common and objectionable arrangement. Sixty-eight per cent. of houses examined show the defects last mentioned; that is to say, the sinks, baths, or fixed basins are connected with the drain or soil-pipe, a trap of some kind generally, but not always, forming a partial security against sewer gas.

As mentioned before, the only ventilation in this case is such as will permit the issuing sewer gas to find its way into the house. It is by no means unusual to find no provision at all for ventilation, or to find the ventilating-pipes so small that they are totally useless. In more cases than one I have found the soil-pipe carried up as a rain-water pipe into the attics, where it received rain water from two gutters, one from each side of the roof, and discharged all the sewer gas which escaped by it. Generally, the drinking water cisterns are situated in such attics.

It may be noted, in the other drawing (Fig. 2, p. 180), that a trap is fixed on the main drain, which will keep back almost all sewer gas, and that ventilating-pipes are so arranged that a constant circulation of fresh air exists through the whole drainage system, and will carry away with it any little sewer gas which passes through the trapping water.

Whilst on the subject of ventilating-pipes, I must not forget to show to you a somewhat curious case of obstruction of a ventilating-pipe. I have the top portions of the pipe in question here. There were two such 4-inch pipes, acting as the ventilating-pipes of the house drains of a well-known scientific professor in London. In each case, as here seen, there was a bird's-nest completely filling up the top portions of the pipe.

We shall now pass on to the water-supply arrangements in the house. I need scarcely say that the most perfect water-supply arrangement does not necessitate the existence of cisterns in the house at all. This is beside the mark, for the reason that in London, to which I wish to confine my remarks, the supply of water to the greater portion of the town is intermittent, so that cisterns are a necessity.

Water, even in London, is almost always delivered in a sufficiently pure state to be drunk, but it is a very common thing for it to be contaminated in the cisterns. Even if there be no actual disease germs carried into the water, there is liability of deterioration from the mere fact of a large quantity of water being stored for a long time before use. If the cisterns are of so great size as to hold as much water as is used in, say, three or four days, it follows that all water drawn has remained in these cisterns for an average time of several days. This is by no means likely to improve its quality, but, on the contrary, if it does nothing else, it renders it flat. There are far more dangerous causes of contamination than this, however. The commonest of these is to be found in direct communication between the drains and the cisterns through the overflow-pipes of the latter. This is shown on the drawing. It will be seen that there is a trap on the pipe by way of protection against the sewer gas. This is a by no means uncommon arrangement; but, as will be readily understood, such a trap is absolutely of no good. An overflow pipe to a cistern is merely an appliance to be put in use in case of an emergency; that is, in case of derangement of the ball valve through which the water enters. As a matter of fact, an overflow may not occur from year's end to year's end—probably does not—and, as a consequence, the trap soon becomes dry, and the temporary security afforded by it is lost. In 37 per cent. of houses inspected we have found direct communication between the drain or soil-pipes and the drinking-water cisterns.

Another means by which the water of cisterns is contaminated is by their being placed in improper positions. Quite frequently, a cistern in which drinking-water is stored, is situated in, or even under, the floor of a w.c. I have known more than one case in which the drip-tray under a closet actually discharged into a cistern.

It is even possible for contamination of water to occur through the mere fact that a water-closet is supplied from a certain cistern. With a water-closet supplied by the modern regulator valve apparatus, this is most unlikely; but it will be readily seen how it may occur with such an arrangement as that shown on our drawing, which is common. Here it will be seen that for each water-closet there is a plug in the cistern. This plug is so arranged that when it is raised by the wire which connects it with the water-closet branch, it suddenly fills what is called a service-box, this being a subsidiary cistern fixed under the body of the main cistern, and in direct communication with the water-closet. After the

water has run out of the service-box, this is free to fill itself with foul gas from the water-closet by the service pipe, and the next time the plug is lifted this same foul gas passes into the water, which absorbs a part of it.

There are many other points in the drainage arrangements of a house which may possibly become causes of danger, such as surface traps in areas, &c., but I shall not take up your time with a description of these to-night.

I have, in talking of the drain of a house, considered it as a single length of pipe; but it must be remembered that in any drainage system, except the most simple, there are branch drains, often many of them, and that these are liable to the same evils as the main drains, and require the same attention. In fact, seeing that less water is likely to pour down them, they require more attention.

A paper on the subject of inspection of houses would be quite incomplete were it to contain only an account of the defects to be found, and to leave out altogether any description of the methods in use for discovering such defects. To describe to you fully how this is done, would be quite beyond my scope to-night, as it would take up much time; moreover, it is impossible to depend in all cases on any one set of methods, the general intelligence of the inspector being the thing which is of most consequence,

Looking at the diagram before you, where the house and ground are in section, and where, so to speak, you have the power of seeing through walls, soil, flag-stones, and so forth, it doubtless appears as if it must be an easy matter for a man to lay his finger on each and every fault and say "this is wrong." But try to transfer your minds from this diagram to any house of which you know the exterior parts, but of which you have seen no section, of which you do not know where or in what direction any of drains or pipes run, or even if there are any, and it will be evident that the matter is not so easy as at first sight appears.

I shall suppose just such a house as the one here illustrated to have come under the hands of one wishing to inspect it, for the purpose of discovering what are the faults of the drainage system.

One thing that is absolutely necessary for such inspection, and without which it would be quite incomplete, is to open down to the drain. This should be done at the nearest point to that at which it leaves the premises. There is no absolute guide to tell where this point is, but after some experience it is generally possible to hit upon the spot with very little searching. In the house illustrated it would be under the front area or cellar. The ground should be entirely removed from the drain for at least two lengths of pipe. I should here mention that in the drawings all the dimensions from back to front, such as width of area and cellar, have been somewhat compressed to allow of showing the pipes on the largest scale possible. It is also very desirable that a portion of the ground over the top portion of the drain should be removed.

We may next take the point of trapping of the main drain and ventilation of the system. It will be seen that, in the case of the drawing of the imperfect arrangements, the drain is shown to be in direct communication with the sewer. The consequence is that any leakage which may exist in the house drain permits gas not only from the drain itself, but from the sewer also, to find its way into the house.

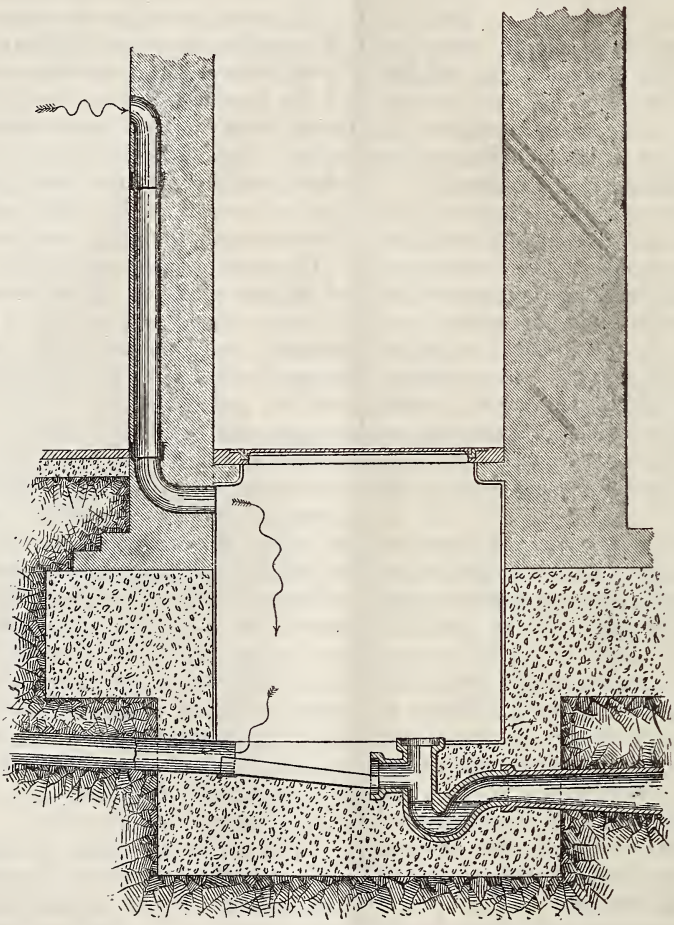
The engineer will now be able to tell much of the state of affairs. He will see of what size the drain is; he will be able to tell of what material the joints are made, taking those exposed as samples; he will, in all probability, find the ground under the pipes soaked with sewage, and be able at once to say that the drain is in a leaky and bad condition; he will find whether it is properly supported on concrete, or has been "tumbled" into the soil; he will be able readily to discover what is the total fall in the drain from back to front. At this stage of the proceedings, the drain itself should not be opened; but, on the contrary, if the taking up of the ground should have exposed any joints which are evidently leaking, these should be made temporarily good with clay. The reason is, that it is desirable, before anything has been disturbed, to test the system for the purpose of discovering what amount of leakage there is into the house.

There are various ways of doing this, but the two commonest, which I intend to describe and illustrate to you are those known as the "peppermint test," and the "smoke test."

The smell of peppermint is well known, possibly to some of us unpleasantly well known, but probably its excessive pungency when in the form of the oil, and when brought into contact with hot water, is not generally understood. I have here a pail of hot water, and a bottle containing a little Mitcham oil of peppermint. I shall pour only a drop or two of the oil on to the surface of the water, when I imagine the smell will instantly be unmistakably evident throughout the hall.

It will readily be understood that if such an excessively pungent mixture as this be introduced into the drainage system of a house, even the smallest leakage will become evident. Suppose the least possible defect to exist in any joint of any of the pipes, a strong smell of peppermint will be evident near the defect. The only difficulty is in finding a place to introduce the peppermint. It will be quite evident that it is no use to pour it into any of the appliances in the house, as, were such done, this smell would so rapidly permeate the whole of the premises, by way of the staircase, passages, &c., that time would not be allowed to detect the leakages. Some means must be discovered of getting the peppermint in from the outside. This is not always possible, but generally it is. In the case illustrated, there would be no difficulty. The rain-water pipe at the back admirably suits the purpose. One person gets out on the flat roof, near the top of the pipe, and provides himself with peppermint, and four or five gallons of water, as nearly boiling as possible. Meantime, all doors and windows are closely shut, and persons are stationed about the house to observe if the smell expected becomes evident, and to locate, as far as possible, the point from which it issues. The man on the roof pours about half-an-ounce of the oil down the pipe, and follows it with the hot water. He need then retreat from the place a little, for the peppermint-laden steam which will come from the pipe is blinding in its pungency. As soon as possible, he plugs up the top of the pipe with a towel, or some such thing, to prevent the occurrence of the vacuum which would otherwise be in the pipes, and which would tend to draw air from the house into the pipes instead of from the pipes into the house at any leakage. It would probably not be a minute before the people in the house would perceive the smell at various places. The manipulator of the peppermint must remain perched on the roof until those inside have had time to make their observations, otherwise he will infallibly bring the smell with him.

Fig. 4.



Detail of Disconnection Chambers in Fig. 2.

The test described is an excellent one. It is searching, and is simple in application, but it has one drawback. It is impossible by means of it exactly to localise a leakage. This drawback does not apply to the smoke test. Here I have a smoke machine. This is nothing more nor less than a centrifugal pump attached to a vessel for generating smoke. The pump pumps smoke out by this pipe, which may be inserted in any pipe in direct communication with the drain or in an aperture

made for the purpose. I give you an example of its powers. Merely a puff, as I do not wish to smother my audience.

The test is, in all respects, similar to the peppermint one, except that the leakage is not smelt but seen, and as we all know seeing is believing.

After the test has been performed the drain may be opened. This may be done by breaking into a pipe in front, by breaking off a collar, or by punching a round hole in the pipe. In any case it will be possible to judge much of the condition of the drain by the manner in which water runs through the pipes. If we have discovered that there is sufficient total fall, we can now see whether or not it is uniform. We shall, as remarked before, find in six cases out of every hundred examined that there is total stoppage, that no sewage whatever leaves the premises, and that consequently it must all be depositing under the basement.

If the drain, after all tests so far applied, and from what can be seen of it, appear to be in good condition, it may be further tested by filling, or attempting to fill it with water. There is probably not an average of one drain in a thousand in London which would remain full of water for an hour. For the rest it is necessary to examine all appliances, to trace the pipes from them, and sometimes to test these pipes.

The engineer has now completed his inspection, and has but to consider how he will make the best of a bad job, and put things to rights. At the beginning of my paper I expressed my intention of confining myself to a description of defects, and said I should not describe what I considered a perfect system, I shall, however, point out to you one or two of the chief features of the arrangements in the house which I call well drained.

Most notable, probably, is the small size and sharp fall of the drain-pipes. Further than this, it will be seen that the drain is disconnected from the sewer by a trap, and that it is accessible for inspection throughout, simply by lifting certain iron covers (Fig. 4, p. 184). A close examination would show that every foot of drain-pipe and discharge-pipe is so ventilated, that there will be a current of air through it; that no appliance discharges into the drain direct, but that there is an atmospheric disconnection in every case; that air from discharge-pipes of sinks, &c., is all trapped from the house; that there is separate water supply for closets, and for other purposes; and that no cistern has any connection with the drains. Further will be noticed, the difference in construction of the closets, &c.

I have, in this paper, confined myself to the subject of the drainage arrangement of houses. It must not for this reason be supposed that I am blind to the questions of heating, ventilation, and so forth. On the contrary, I beg you to understand that I consider these questions most important, but that time will not allow me to enter into them.

I shall finish my paper by repeating a warning given to you by Professor Fleeming Jenkin, when he spoke before you two years ago. He warned you against sanitary enthusiasts, against the man who will hear of nothing less than the pulling down and rebuilding of your house; who will not allow you to have wall-paper, carpets, or even wooden floors, but who insists on tiles and such like everywhere; who insists that not a drop of water shall be drunk unless it is analysed; and who, did he have his way, would verily make the life which he attempts to protect not worth living. Against such, I, too, would warn you. Remember that, in going beyond a certain point, you are straining at a gnat whilst you swallow a camel. In a city like this, every cubic foot of air which you breathe carries with it a certain per-centage of sewer gas, and if, in regard to your own house, you see that the conditions enunciated in the beginning of my paper be carried out, this per-centage will not be appreciatively added to by any fault over which you have control.

I have to thank certain gentlemen for the assistance they have rendered me to-night in enabling me to show you these examples of how not to do the thing. These are Mr. Hellyer, Mr. Lucas, Mr. Francis Botting, Mr. Clemence, Mr. Scott-Moncrieff, of the North British Plumbing Co., and his representative, Mr. Dodds, who has shown the smoke machine in action, also Mr. Robert Davies.

DISCUSSION.

Mr. Robert Rawlinson, C.B., said he quite agreed with Mr. Burton that houses required careful examination, and if this had not been done recently, the chances are that they were in a bad condition. He spoke from experience of houses of all classes, from Windsor Castle down to common lodging-houses; and though what had been said was not new to him, there was abundant necessity for its being repeated incessantly. He often found that persons, though they acknowledged that their houses

were defective in sanitary matters, yet shrank from the expense necessary to put them right. Such persons were, in his opinion, most foolish, for nothing was of any value compared to human life and health. If a man could only, by the greatest possible shifts, spare what was requisite to put his dwelling-house into proper order, he would, if he were wise, make the effort, because it was the foundation of the health of himself and his family. He was very sorry that, in many cases, the process was a very expensive one, though when houses were properly built from the beginning it would be very cheap. One principle which should never be departed from in the construction, whether of a palace or a cottage, was that no drain should be laid under any portion of the building. In London, where houses were built in streets, with the kitchen, scullery, and closet at the back, and the main sewer in front, it became necessary to drain under the houses; but in such cases, cast-iron-pipes with lead joints should be employed, with ventilation back and front, and thus any chance of sewer gas entering the house might be avoided. Even the best stoneware pipes were liable to crack and leak at the joints. Another prevalent evil was, that the main sewers in some of the London parishes had not proper and safe junctions provided for the entrance of the house drains, so that the sewer had to be broken into for the purpose, and very often a fine was also levied for entering the sewer, which was practically a premium to the builder not to connect the drains. This was the case with many houses in the west of London; and even when the connection was made, it was not done properly, so as to prevent the inlet of air from the sewer into the house drain.

Mr. Rogers Field said he found, from an experience of eight or ten years in these matters, that the majority of houses were very defective, and out of about a thousand he had examined, he had only found three which were sound. It was impossible to tell whether a stoneware drain was sound, without thoroughly testing it with water, and very few, indeed, would stand the test. In New York, the difficulty had now been so recognised of making good joints in such pipes, that a regulation was passed that all drains under houses should be of cast iron, jointed in the same way as water or gas pipes. The sink traps, which had been referred to, were a constant source of danger. Though defects in them were not always discovered without a careful examination, he was sorry to find they were still being constantly used, even in large houses.

Mr. E. P. Bailey-Denton, said all sanitarians were agreed as to the mode of remedying the evils which had been described, and it only remained with the public to have the remedies carried out. One or two points he thought had been omitted; for instance, the danger from the waste-pipes of safes under water-closets and baths, and the great importance of disconnecting the house drain from the sewer had hardly been dwelt upon sufficiently; nor was the best method of ventilation sufficiently explained, to make the public see the necessity for it. The flushing of drains was another point of importance. He agreed with Mr. Burton that the theories of sanitarians must not be pushed too far, and he would ask him whether there was not a possibility of falling into this danger, by insisting rigidly on an entire separation between the drinking-water cistern and the one for supplying the water-closet in cases where improved closets were used, the pipe supplying them being always full of water.

Mr. E. C. Robins said he could confirm everything said by Mr. Rogers Field as to the difficulty of laying stoneware drains perfectly; for he had never found one which would stand the test of water being put into it. He had used iron pipes, and had formed a subway under the house, in which all pipes were carried. With iron pipes properly leaded, both for drainage and ventilation, he had been able to dispense with traps altogether. Earthenware pipes required the very greatest care in laying, and yet, as a rule, builders employed common labourers for this work. Some employed bricklayers, and where great care was used, the result might be satisfactory. He agreed with Mr. Bailey-Denton as to the importance of flushing, and had been very much pleased with Mr. Rogers Field's siphon apparatus for this purpose; it could be so arranged that, according to the rate at which the water was allowed to flow into it, the drains could be flushed twice or three times a day, or oftener. The paper, though it contained nothing new, was very valuable, and the per-centages given would be very useful.

Dr. Bartlett said there were other means besides those which had been mentioned by Mr. Burton, for detecting the escape or presence of what was often called sewer gas, but which he preferred to call sewer air. Musk, for instance, was not a gaseous body, and made its presence apparent by the diffusion of very minute particles; but there were other substances, the detection of whose presence did not depend on the olfactory nerves, and about which there could not possibly be a mistake. If acetate of lithium were passed down a drain, its presence could be detected in the spectroscope by its characteristic line; tellurium again gave another definite indication. He had tried these two substances, putting them intothe water supply, and detecting their presence in the sewers twenty minutes afterwards; and, on one occasion, on putting them into the sewers he had detected their presence in the water supply in an hour and a quarter. He endorsed everything which had been said as to the importance of not admitting sewer air into houses. He had seen a large building of the best description, in which there was the entire accumulation of six years, not one particle having passed into the sewer. The importance of disconnection was not, he held, as new as some people supposed, the old-fashioned method of a privy at the end of the garden

being an exemplification of it. In many cases, the sewer was an elongated cesspool, and by the process of fermentation, not only gaseous matters, but solid matters, which were contagious as well as infectious, were carried into the house, and if they did not cause specific disease, caused that condition of lowered vitality which predisposed to every kind of disease.

Mr. WILLIAM BOTLY said he had known, within a short period, two cases of typhoid fever arising from defective drainage, in houses of a rental of about £200 per annum; and in a recent case, the stoppage in the pipes was occasioned by an accumulation of fat. There was nothing in the paper about compulsory inspection, but he considered that most important. Not long since, he saw a row of large houses, within the four-mile radius from Charing-cross, some of which had been occupied several times, although they were unconnected with the sewer. It ought to be compulsory on architects and builders to see that the connection was properly made. In his native city, Salisbury, where great attention was paid to sanitation, the death-rate had been reduced from 27 to 17 per 1,000.

Mr. COLLINS said reflections were often made on architects with regard to these matters; but there were probably not more than 5 per cent. of the houses built which had the advantage, or disadvantage, of an architect's superintendence at all. He agreed that there was a difficulty in laying down stoneware drains satisfactorily, but it could be done; the greatest difficulty was to get the work properly carried out, and it could only be ensured by having some one to inspect its progress throughout. He had frequently found a most admirable system fail from defects in carrying out the work, and it was therefore very important to have a simple system which would admit of easy re-inspection. He had used Mr. Field's siphons very largely, but they were so powerful in action that they sometimes emptied the traps. This could easily be obviated by a practical man, and did not detract from the value of the siphon, but it required to be borne in mind. It had been said that there ought to be compulsory examination of every house, but it was already provided, by the Metropolis Local Management Act, that no house should be even inhabited until it had been certified by the surveyor of the parish. Being a vestryman of Paddington, he had often tried to get this carried out, but the answer always was, that it would require too many clerks to carry it into execution. Another important matter was the financial question. A man would willingly spend £40 or £50 to put his house in order, but was deterred by the very large expense some specialists would put him to. He knew an instance of a public institution, where a difficulty occurred owing to the expense, which was estimated at £550, but he had all that was necessary done for £220.

Mr. C. N. CRESSWELL said the technical part of the subject had been amply discussed; but there was a larger and important aspect of the question to be considered. How were the terrible mischiefs to be remedied? He was glad to see so many ladies present, for they were even more interested in this question than men. The evil was most rampant in the suburbs of London, where houses were increasing at the rate of tens of thousands a year. It had been said in that room, by men not given to exaggeration, that of these houses not 20 per cent. were fit for habitation. How was this great evil to be dealt with? Mr. Burton represented a most excellent institution, and there were most eminent men connected with it, but how could any society deal with so vast an evil; whilst it was dealing with about 200 houses in a given area, houses were increased by thousands around them. It was perfectly clear to him that neither philanthropic nor commercial enterprise could deal with this matter properly; it was an affair of the State. The State had taught them, by the Act of 1875, and by the model bye-laws issued from the Local Government Board, how to deal with the difficulty, and there was no necessity for further legislation. If the bye-laws were only put into operation, and men were found able and willing to do it, and the ratepayers would find the money, there would be no difficulty; but there was the real pinch of the matter, the apathy of the public, and that love of buttoning up his breeches pocket which distinguished the British subject. The dictates of science could only be enforced by the arm of the law, compelling the ratepayer to do that which would conduce to his own good and that of his neighbour. It could only be carried out by the principle of local self-government; but there were two sides of the question, dealing respectively with houses already built, and with those about to be erected. They were informed on high authority that while it would cost perhaps £150 to put an existing house of £200 a year, full of defects, into a proper state, £50 would cover the expense if it were done in the building. The only way of approaching the British subject was by showing him that it was worth his while to do what they all agreed was his duty, and as to the manner of doing which all competent authorities were also agreed. He believed this would be accomplished if an official certificate, sealed with the seal of the local authority, were given him, testifying to the healthworthy character of his house, as that would immediately increase the letting or saleable value of his house by the amount he had expended. This certificate should state what had been done, and contain on the back of it a plan of the drains, and, issuing from an independent local authority, would be regarded as an increment of value to the tenement in the hands of the owner.

Mr. LIGGINS said they were all much indebted to Mr. Burton; but the weak point in the paper was that it did not say where the requisite scientific knowledge was to be obtained, which would enable them to get defects in drains detected with certainty.

When some of the finest buildings in London, belonging to the Government, were recently amongst the most defective, how could private individuals expect to get their work done properly? The Vestry of Kensington took up this subject very warmly some four years ago, but they found there were no clauses in the Act of Parliament sufficiently strong to enable their surveyors to carry out the rules which they made. If they could get such certificates as Mr. Cresswell had spoken of, no doubt these would be very valuable, but under the present law it could not be done. Again, when they found experts differing on certain technical points, how could the public decide between them? He believed the evil was much exaggerated by sanitary engineers, and that water-closets and drains did not generally communicate with the drinking water.

Mr. G. E. Mineard wished to say a few words from the builders' point of view. He had a copy of a report on a house which had been arranged on the system described by Mr. Burton, in which an expert suggested that the manhole should be closed, and the iron ventilating-pipe removed, and replaced by a common zinc ventilator. How, then, was it possible for a builder desirous of carrying out the best system, to do so? His own experience was, that the sewer gas would come out at the place where Mr. Burton said the fresh air would go in; in fact, he tried that plan years ago, and found it a failure. The air going up through the soil pipe must be met by the volume of water and sewage coming down, of 800 times its specific gravity, and any sane man must see that the current being reversed, it must blow out into the area. Everyone who had written on this subject admitted that they could not tell at all times which way the air would be going. As for sanitary defects, there could be no doubt there was room for improvement on every hand. He had seen drains taken up at Sandringham-house in which he could lay his hand, and at Eastwell-park he had taken up one which was eighteen inches thick with solid sewage, and yet that was supposed to have been put into proper sanitary condition within eight years, under the supervision of a first-rate sanitary expert. How then, could the public know whom to apply to. He believed if any good were to be done they must have an Act of Parliament; first settle what was the best thing to be done, and then make everybody do it. At present all was confusion, and many of the sanitary engineers were grinding their own axes by frightening the public. He had had a bell-trap, with all its imperfections, prescribed by a surveyor, and had had within the last three months to connect safes with waste pipes, by order of a surveyor. If the Board of Trade, or any responsible body would undertake, for a certain fee, to indemnify him against others coming to upset what had been done under their supervision, he would willingly go in for it. At present, a builder, however conscientious, had no safe guide, and consequently the public did not appreciate sanitary appliances. If the gentlemen who preached this doctrine would only build some sanitary houses, and invite builders to see what could be done, something might be learnt; but at present, the whole thing was in a state of chaos.

The Chairman, in proposing a vote of thanks to Mr. Burton, said the result of the whole discussion was to show the great importance of thoroughly educating the public in the matter. He could not agree with the last speaker in wishing that a hard and fast rule should be laid down by Act of Parliament, for if that had been done eight or ten years ago, they would have been much less advanced in sanitary matters than they were at present; and he did not think they had yet reached absolute perfection in sanitary science. He hoped they would still go on striving and educating themselves, perhaps by occasional failures, until they had obtained a higher degree of excellence.

The vote of thanks having been passed unanimously,

Mr. Burton, in reply, said it was perfectly true that his paper contained nothing new to sanitarians, and he could not presume to teach men like Mr. Rawlinson, and several other gentlemen who had spoken; but his remarks were intended for those who did not understand sanitary matters; for if it were generally known that houses were in such a defective condition, he did not believe they would be allowed to remain so. As Mr. Rogers Field had said, the testing of drains was most important, and not only so, but repeated testing was necessary, because a drain might be perfect now, and might let water out next year. For that reason he always recommended iron drain pipes, because the risk of breaking was reduced to a minimum. He could not agree with Mr. Mineard that where the air inlet was at the bottom and the outlet at the top the air would be most frequently found going out at the inlet. He felt sure he should be borne out by men who had tested thousands of drains, in saying that in ninety-nine cases out of a hundred the air would be found to pass in at the inlet strongly, and as for the other minute, it would do no harm to stop the ventilation altogether for the short space of time, which could be easily done by placing a mica plate over the air inlet. Mr. Bailey-Denton had remarked that he had not gone far enough into details, but he fancied he had occupied quite sufficient time as it was. He should have liked to say something on the interesting matters brought forward by Dr. Bartlett, but would not detain the meeting longer at that late hour.

Mr. Edwin Chadwick, C.B., who was unable to attend the meeting, writes to the Secretary that he considers the statement of the varied experiences of skilled specialists in house drainage of the highest sanitary importance, and Mr. Burton's paper as most valuable, more especially the remarks on the application of the peppermint test.

During the evening Mr. Hall's Type-writer and Capt. Heathorn's Steering Apparatus were exhibited in the Library. The latter has already been described in the *Journal* (vol. xxvii., p. 634, and vol. xxx. p. 916). Mr. Hall's Type-writer differs considerably from the machine previously known in this country under that name. The alphabet of type is formed on a small square plate of flexible vulcanised rubber. This plate is mounted on a frame, to which motion in any direction in a horizontal plane can be given, so that any letter required can be brought over an opening in a guard-plate, below which is a cylinder carrying the paper. The letter is printed by depressing the frame. The guard-plate above-mentioned also serves as an inking pad, and the depression of the frame brings all the type (except the one letter being printed) down on its upper surface, and causes them to take up ink. On the framework of the machine, above the printing mechanism, is a fixed perforated plate, with an alphabet upon it. A handle, connected to the printing frame, is so arranged that when a pin thereon is placed in the perforation, labelled with any particular letter, the corresponding type is brought to the opening in the guard-plate, and printed. Suitable mechanism is provided, by which the paper cylinder is traversed along as the printing proceeds, and shifted at the commencement of each fresh line. The advantages claimed by the inventor are the portability of the machine, on account of its small size (the total weight being 5½ lbs.), and the fact that a variety of classes of type can be employed. A full description of the machine, with illustratrative figures, will be found in the number of *Engineering* for January 5.

Miscellaneous.

ON SILK-PRODUCING BOMBYCES REARED IN 1882.

By Alfred Wailly
(Membre-Lauréat de la Société d'Acclimatation de France).

The most important silkworm bred this year (1882), is my new hybrid *Roylei-Pernyi*, mention of which has already appeared in my reports on the rearings of 1881, and also in the numbers of the *Journal of the Society of Arts*, June 30th and September 8th, 1882. But before going into details on this and other specimens, I shall say a few words about the weather, and its consequent effects on the pupæ and rearing of the larvæ, &c.

Last year (1881-82), there was little or no winter weather. Cocoons of *Atlas* and *Mylitta*, sent to me direct from Ceylon, arrived in London at the end of December, 1881, and beginning of January, 1882. *Selene* and *Roylei* cocoons, imported by one of my correspondents from the Himalayas, were sent to me in January. Moths from these cocoons emerged as follows, no doubt in consequence of the extraordinary mildness of the winter. In January, two *Atlas*, one *Mylitta*, four *Selene*, and two *Roylei* moths emerged. In February, moths emerged as follows:—On the 12th, two *Selene* (crippled); on the 14th, one female *Selene* (perfect); on the 15th, one male *Selene* (perfect); on the 17th, one male *Selene* (crippled). On the same day, one male *Roylei* (perfect); on the 23rd, one *Roylei* (male); on the 24th, one *Roylei* (male); on the 8th of March, one male *Roylei;* on the 11th, one male *Roylei;* on the 12th, one male *Roylei;* on the 14th, one female *Roylei;* on the 17th, one female *Roylei*. On the 20th of March, one female moth of *Cecropia* (North American silkworm); this is the first time I saw the emergence of this species so early in the season. On the 31st of March, another female *Cecropia* emerged, and also one female *Roylei*. On the 4th of April, one male *Roylei* emerged. After this, no further notes on early emergences were taken.

The mild and afterwards warm weather having continued, I think, without any interruption, till the end of May, the consequence was that the moths, which generally emerge in May, emerged in April, and those of June emerged in May. Such weather as we had till the end of May is of course favourable to silkworms, which require a long time to develop themselves in the larval state in northern countries, such as *Mylitta* and *Atlas*. Warm weather in early spring is also favourable to species like *Cecropia Piri*, and others which are single-brooded; but to species which are double-brooded, or susceptible of becoming double-brooded even in moderate climates, such as *Pernyi*, and my hybrid *Roylei-Pernyi*, an abnormally and uninterruptedly warm weather has for its effects to bring forth a second brood of larvæ, which, in England and other northern countries, it is impossible to rear with any chance of success.

The above remarks refer only to silkworms reared in confinement, and especially in warm rooms. My own worms, reared in the open air all the time, were not at all affected by the effects of the unusually warm spring; the cocoons, in fact, were not formed till late in the season, end of August and beginning of September.

Mr. J. Turnbull, one of my correspondents in Scotland, who always reared his larvæ so as to obtain the most satisfactory results, obtained this year his cocoons of *Pernyi* and hybrid *Roylei-Pernyi*, about the middle of July.

The larvæ were reared in a room which was rather warm. The consequence was that the moths of *Pernyi* emerged in September and October. Only about 20 of these cocoons are left now (November), from a lot of about 70, sent to me early in September.

Larvæ from ova of these *Pernyi* moths hatched here on the 1st of November, although they were kept in the coldest place I had at my disposal: but the last eggs obtained have not hatched yet, and have been in the open air ever since they were laid.

As the ova of *Pernyi* and those of many other species do not hybernate, or have not been known to hybernate, I recommended to my correspondents to keep the cocoons in a very cold place, even in an ice-room, if possible, so as to prevent during the autumn the emergence of the moths of *Pernyi*, and especially those of my new hybrid *Roylei-Pernyi*.

Some experiments are to be made for the preservation during the winter of such fertile eggs as were obtained in the autumn. I doubt the success of the experiment, but should it take place, it will be a most important discovery. As must have been seen from my remarks, the moths and worms of *Pernyi*, and my hybrid *Roylei-Pernyi*, were in advance of their usual time, in consequence of the warm weather in the spring.

As I am now looking over some letters of Mr. J. Turnbull, I shall reproduce some of his remarks on my new hybrid *Roylei-Pernyi*. In a letter dated 28th of March, 1882, he says, respecting the rearing of the hybrid in 1881, that the larvæ hatched on the 9th of June, and the spinning of the larvæ commenced on the 25th of July. One larva which he measured was 2⅛ inches round, and 7 inches long. The larvæ, he says, were very much like *Pernyi*, but much larger; one male moth emerged in the autumn (1881), different in shade of colour from *Pernyi*.

In his letter dated 25th July, 1882, Mr. J. Turnbull says on the rearing:—"We have had an awful time of it to provide food for such a family, but they are spun up at last. I am sorry I was not able to keep the two species (*Pernyi* and hybrid *Roylei-Pernyi*) separate, as they have all had to be fed in the house. I tried some in a glass-fronted cage out in the yard, but found they would not feed, and some of them died in consequence of the trial." In a letter, dated 5th September, 1882, Mr. Turnbull says:—"Five moths (whether *Pernyi* or hybrid is not stated) have come out, and I have had one pairing and over 100 eggs. As it is too late in the season to try and rear the larvæ, I have buried the eggs beside a north wall, and sealed up the box water-tight, to try and preserve them till spring."

Dr. Herm. Kolisko, of Vienna, who, last year, bred several species with the greatest success, obtained this year a very poor result from the rearing of *Telea Polyphemus* and *Antheræa Roylei*. With respect to my new hybrid, he says:—"I only have nine larvæ; they are in the last period, and of considerable size, larger than *Pernyi* and *Roylei*." Vienna, August 1st, 1882.

The following is a list of the species of silk-producing Bombyces, and other lepidoptera I had in stock for the purpose of reproduction, but, as usual, I failed with many of them, owing to various causes enumerated in previous reports:—

Antheræa Pernyi (oak silkworm) and *Attacus Cynthia* (ailanthus silkworm), both natives of North China.

Of Indian species, I had *Antheræa paphia* (*Mylitta*); *Antheræa Roylei* (the Himalaya oak silkworm); *Attacus Atlas*, which feeds on barberry, apple, plum, willow, &c.; *Actias Selene*, which feeds on walnut, cherry, pear, apple, &c.; and *Cricula trifenestrata*, a polyphagous species, which will probably feed on oak, as *Antheræa paphia*.

Roylei-Pernyi, obtained by the crossing of *Roylei* female with *Pernyi* male.

The species from the United States of North America, which I had in stock this year, were:—*Samia Cecropia* (plum, apple, cherry, willow, &c.), *Telea Polyphemus* (oak, birch, maple, willow, &c.), *Actias luna* (walnut, cherry, hazel, &c.), *Dryocampa regalis* (walnut, &c.), *Dryocampa stigma* (oak), *Arctia Acrea* (convolvulus, grape, willow, &c.), *Ceramica picta* (maple, maize, cabbage, burdock, &c.), and a *Noctua* from Georgia, feeding on oak.

Besides these exotic species, I had a certain number of European species.

Antheræa Pernyi.—Moths began to emerge on the 29th of April; a few larvæ were bred successfully in the open air.

Attacus Cynthia.—Moths began to emerge on the 23rd of May, very weak for the most part, and only a few pairings could be obtained. My stock of *Cynthia* had degenerated, but a very good pairing was obtained with a wild Himalaya *Cynthia* (male), and one of the largest acclimatised *Cynthia* (female). The batch of eggs obtained from this pairing alone, I preserved for rearing; unfortunately, the young larvæ, shortly after they had been placed on the ailanthus leaves in the garden, were all destroyed, excepting a few, by lady-birds, which swarmed all over the garden. This little aphidivorous beetle (the lady-bird) does not confine its labours to the destruction of the aphis, in which case it is a most useful little insect; it preys on the young silkworms, and is destructive, both as a larva and as a perfect insect.

In my report on the rearings of 1881, there is an article on the wild *Cynthia*, which had been imported from the province of Kumaon. The moths, instead of emerging in June, as the acclimatised *Cynthia*, emerged in the autumn; but five cocoons hybernated a second time, and produced splendid moths, the first on the 5th of June, the last two, which were female, on the 21st of June. The acclimatised *Cynthia* were the first to produce their moths, and they commenced to emerge from the 23rd of May, the last emerging on the 6th of June. This is another instance of the irregularity and uncertainty in the emergence of the moths of Indian and some other species, when first imported into Europe.

Antheræa paphia (*Mylitta*).—A quantity of cocoons of this species were sent to me from Ceylon, and a small number from Madras, but no pairings were obtained. The moths emerged as follows:—May the 10th, one female; 23rd, two females; 24th, one male; 25th, one female; this latter paired with a male hybrid *Roylei-Pernyi*, but the ova were not fertile. On rhe 27th of May, one female emerged. All these were from the Ceylon race. From the Madras race I obtained moths as follows:—On the

30th of May, one female; on the 1st of June, one female; 3rd of June, one female; 14th of July, one female; and on the 3rd of August, one male.

Antheræa Roylei (Himalaya oak silkworm).—The rearing of this species this year, in spite of very bad weather, was very successful. In previous years, I found *Roylei* very difficult to pair; this year they paired readily. The moths were remarkably fine and large. I obtained, however, only four pairings, but this was due to the moths accidentally emerging, for the most part, in batches of males and females. For instance, from the 2nd of June to the 10th, all the moths were male; from the 10th of June to the 13th, ten male moths emerged and only one female; and from the 21st to the 4th of July, six female moths emerged; they were the last. The moths were nearly two months to emerge, from the 11th of May to the 4th of July. The pairings of *Roylei* took place, the first, on 28th of May; the second, on the 2nd of June; the third, on the 13th of June; the fourth, on the 18th of June. On the 24th of May, a male *Pernyi* paired with a female *Roylei*, and on the 29th of May, a male *Roylei* paired with a female *Pernyi*; all the ova were fertile.

The ova of the second pairing of *Roylei*, that of the 2nd of June, which I had kept for rearing, began to hatch on the 27th of June, and the first cocoons were obtained on the 2nd of September. As previously stated, the larvæ of *Roylei*, of *Pernyi*, and of my hybrid *Roylei-Pernyi*, are very similar. However, I remarked that in the fifth stage (I had not time to examine the larvæ in the first stages), the larvæ of *Roylei* are of a deeper green than those of *Pernyi* or the hybrid; besides, the number of the large brilliant metallic spots on the sides are from five to seven, instead of two or three, as on *Pernyi* or the hybrid. The metallic spots on the lateral band on each side of the body vary in number, according to individuals in the three species.

Contrary to other Indian species, the *Roylei* moths always emerged during the season; the pupæ never hybernated a second time.

The larvæ were reared in the open air, on an oak tree, covered with netting; but at the fifth stage, the foliage having been entirely destroyed, they had to be placed on cut branches.

Attacus Atlas.—Of this species I had a considerable number of cocoons, received from Ceylon this year (1882), and also a few from the Himalaya race, which had hybernated twice. The latter produced three male moths of large size on the 1st, 3rd, and 5th of August.

From the large number of cocoons of the Ceylon race, I only obtained a few moths; most of the remaining cocoons are alive and apparently in good condition. Only one moth emerged in June, and none in July. This was very likely due to the cold, wet weather we had in June and the greater part of July. The *Atlas* moths emerged as follows:—May 24th, two females; 26th, one female; 27th, one female; 28th, one male; 29th, four females and one male; 30th, one male; June 3rd, one male; August 11th, one male; September 8th, one female; 29th, one male; October, 7th, one female. On the 30th of May, I obtained one pairing, and about 100 eggs, which never hatched, although they never were depressed. My impression is that the larvæ died in the egg, in consequence of the cold, wet weather. This was a failure I did not expect, with such a large number of cocoons.

Actias Selene.—Of this species I had a large number of cocoons of the Himalaya race, and a few of the Madras race. Only one moth of the Madras race emerged, and that late in the season, on the 3rd of October. The other cocoons are in good condition, and will probably emerge next year. *Selene* cocoons, like other species from Southern India, seldom produce moths the first year; cocoons from the Himalaya, on the contrary, with the exception of *Atlas*, I always found to emerge the first season; I do not remember having seen any to hybernate a second time.

The Himalaya *Selene* were this year of superior size and beauty. The moths commenced to emerge on the 30th of May, and the last emerged on the 29th of August. I obtained six or seven pairings, and therefore an immense quantity of fertile ova. A large-size female *Selene* may lay from 350 to nearly 400 eggs.

The first ova which hatched, on the 21st of July, were those of a female, of which I had not seen the pairing. They had been laid on the 1st and 2nd of July. On the 1st of July, a male *Selene*, placed in a cage containing a female *Selene* and a female *Actias luna*, paired with the *luna*, but the eggs did not hatch. The ova of a pairing which took place on the 4th of July, hatched on the 23rd of July. From the above, and also by referring to the dates of the other pairings and hatchings of the eggs, I see that the eggs all hatched about twenty days after they had been laid. Had the weather been hot, the eggs would have hatched in a little shorter time. The larvæ of these two broods, which hatched from the 21st and 23rd of July, were all reared in the open air. The majority, between 300 and 400, were placed on a good-sized nut tree, enclosed in a frame, covered this year with a double fish-netting, in order to protect more efficaciously the larvæ from the attacks of sparrows. These young larvæ, which were very healthy, and bred on the tree immediately after they had hatched, gave me the most sanguine hopes of obtaining a good crop of cocoons, the weather being then favourable enough. But, as last year, all the larvæ placed on that nut tree died of disease, many, however, as last year, reaching the spinning period. From these two experiments, I am inclined to believe that the foliage of that tree was unhealthy, or not sufficiently nutritious. The death of the larvæ was certainly not caused by any inclemency of the weather, the cold wet weather being then over. Last year the top branches and the main stem of the nut tree were cut down, to make it more compact, and easier to cover it with the frame and netting. The result of

this cutting of the main stems was the shooting forth of a larger number of young branches, the foliage of which was, in all probability, too watery, and deprived of most of its nutritive substance. I attribute the death of the larvæ to this cause, because some twenty-four *Selene* larvæ placed on other trees, all close to and touching each other, *i.e.*, one or two apple trees, one pear tree, two cherry trees, and one oak tree, all throve remarkably well, and formed their cocoons. On these small trees, which were also covered with a frame and double netting, were placed, besides *Selene*, some larvæ of *Attacus Pyri*, which, this year, for the first time, formed cocoons, after being bred all the time in the open air. The *Selene* and the *Pyri* larvæ went over all these fruit trees, feeding equally well on all of them; *Selene* larvæ even fed on the oak tree with the *Roylei*.

(To be continued.)

MINING AND REDUCTION OF QUICK-SILVER.

The only countries of Europe where quicksilver is found are Italy, Spain, and Austria; and the production of Italy has greatly increased of late years, owing to the development of the mines of Amiata in Tuscany. The following, according to a paper contributed by M. Bidon to the *Génie Civil*, is the method by which quicksilver is worked at these mines:—

The Amiata mountain, situated on the south-east boundary of the province of Sienna, contains several deposits of the minerals employed in industry, and especially cinnabar, or sulphate of mercury. That in the valley of the Siele is found in an argillaceous lode, in the form of almost invisible particles, and of very rich red masses, sometimes of large size. The vein has been proved for 150 metres horizontally, and 170 metres vertically.

Two shafts have been sunk, one 170 metres deep, and the other 57 metres, with horizontal workings, which cut the lode at three different heights. A preliminary separation of the ore underground furnishes sufficient material for filling up the spaces left by working. The ore from the lower heights is brought to the bottom of the deeper shaft, and raised by a winch to the level of the upper height, whence it is conveyed, by a slightly inclined gallery, to a chamber at the bottom of the smaller shaft, and from thence raised to the surface by engine power. A screen separates the stone from the ore, and also divides the latter into two classes, rich and poor. The ore is run down a self-acting incline, in trucks, to the works, and is reduced by women into small pieces, which are kept as dry as possible.

The Siele works have twelve half-moon retorts of cast iron for treating the rich ore, and three vertical furnaces for the poor ore. The retorts are arranged horizontally, three by three, in four ovens. The mouth of the retort is closed by a cover, luted with clay, and kept in place by a screw and strap. The charge of a retort consists of 100 to 120 kilogrammes (2 to 2¼ cwt.) of ore and quicklime, in the proportion of 1 of the latter to 8 of the former. The retorts are charged every eight hours, and this operation must be performed very quickly, as distillation begins at once. If the retort be not closed directly, there is great loss of metal, and the men's health suffers through the mercurial vapours. The distilled mercury escapes by the neck of the retort, and passes into a receiver, in which cold water is constantly circulating. The mercurial vapours from the six retorts are condensed in one and the same tank filled with cold water; and the metallic mercury is drawn off from inclined channels at the bottom.

The retorts, fired with wood, of which a large quantity is consumed, only serve for the rich ore; the poor is treated in the three vertical furnaces, which are 4 metres high by 1 metre in diameter (13 ft. by 3 ft. 3 in.). Each furnace is closed at the top by a hopper, with two doors, the upper of which has a water joint. Twelve charges are made a day; and care is taken to open the upper door as little as possible. At the bottom of the furnace there is a grating with moveable bars. The charge consists of 100 kilogrammes (2 cwt.) of ore, mixed with a quarter the quantity of charcoal. The charge is only lowered into the furnace by opening the lower door, while the upper one is closed; and a fire is kept burning at the upper part of the furnace, for preventing the escape of the gases. The mercurial vapours and gases of combustion are led by a chimney into condensing chambers. From 150 to 160 tons of ore are extracted from the Siele mines every month, about 22 tons of metallic quicksilver, which is packed in about 300 cans with screw stoppers.

THE SALT INDUSTRY OF CADIZ.

The making of salt has been carried on in Cadiz, on a moderate scale, since the beginning of the last century, but its great development does not go further back than about fifty years. Consul Oppenheim states that the area covered by the salt-beds embraces about 35,800 acres, this being nearly all the land that, but for the embankments, would be under water at high tide. The process of salt-making is a simple one, consisting mainly in flooding the ponds to a depth of about twelve inches at the commencement of summer, and as the evaporation caused by the heat and dry easterly winds progresses, to let on a fresh supply of salt water, this being repeated until the point of total saturation is reached, when the salt crystals are deposited at the bottom of the ponds. These beds, which are made of carefully puddled earth, are kept covered with water during the winter to prevent the formation of cracks or fissures, this being necessary in order to keep the salt as free as possible from earthy admixture. From time to time the ponds are raked, and the salt is placed upon the banks, where it undergoes a final drying before being put up in pyramidal mounds. The work of salt-

making usually commences towards the end of May, and ends in September; during this period, rains are very scarce; when, however, rain-storms occur, the yield of the salt ponds is liable to be much lessened in quantity, and also injured in quality, through the washing of the banks. The greatest damage is, however, occasioned by the absence of the usually prevalent dry easterly winds; winds from any other quarter than east or south-east, are generally cool or moist, and their evaporating power is consequently insignificant. Very heavy rains during the winter also affect the yield injuriously, through the amount of fresh water retained in the ponds, and in the porous soil surrounding them. The mean annual product is estimated at from 250,000 to 280,000 tons, but in consequence of some of the above-mentioned causes, the yields for 1880 and 1881 were respectively only 160,000 and 140,000 tons. Cadiz salt, in ordinary years, contains 94 per cent. of chloride of soda, and is said to be more highly prized for the finer salting operations than any other kind of sea salt. Of the total production, about 20 per cent. is usually retained for home consumption, the remainder being exported to various countries. The number of workmen employed during the salt-making season is about 1,500, and their wages vary from three shillings to six shillings per day, of from nine to ten hours' work. During the winter only a small number are kept, and they are usually employed in making repairs. The salines belong to a number of individual proprietors, who assemble once or oftener each year, in order to establish the selling price of the product. The unit of measurement of salt is the "last," which is equal to about $2\frac{1}{2}$ tons. The price is subject to wide fluctuations, depending as it does upon many factors, such as the year's yield, the quantity produced in the competing districts, the rates of freight, &c. The highest figure on record is said to have been reached in 1856, when fifty shillings per last was paid; at the present time it is at the rate of about twenty-nine shillings per last.

Notes on Books.

A Hand-book of House Sanitation: For the use of all Persons seeking a Healthy Home. A Reprint of Mr. Bailey-Denton's Lectures on Sanitary Engineering which related to the "Dwelling." Enlarged and revised by his son, Eardley F. Bailey-Denton. London: E. & F. N. Spon. 1882. 8vo.

Mr. Bailey-Denton delivered a course of lectures before the School of Military Engineering, Chatham, in 1876, and this book contains a selection from these lectures of all that relates to the house itself. It is divided into two parts, six chapters being devoted to air, and six to water. Under the heading of air, the author deals with questions relating to the site of dwellings and their construction, with external and internal sewage, and with ventilation. In the portion devoted to water, sources of supply, motive powers to raise water for the supply of dwellings, pumps, storage and domestic filtration, and distribution, are severally dealt with. The book is fully illustrated.

Wholesome Houses: A Handbook of Domestic Sanitation and Ventilation. By E. Gregson Banner. New and revised edition, with a chapter on Ventilation of Rooms and Railway Carriages. London: E. Stanford. 1882.

The author deals in this little book more particularly with ventilation, and the results of his system of cowls, although it is not intended merely as an exposition of the Banner system, but is so arranged as to form a guide to the leading features of domestic sanitation and ventilation. Several additions have been made to this new edition.

General Notes.

Abolition of the Mexican Export Tax on Precious Metals.—In order to give a impetus to mining, the tax on precious metals exported from Mexico, was abolished from 1st November last. This tax of 5 per cent. *ad valorem*, added to the high freight, rendered working the mines impossible.

Electrical and Industrial Exhibition at Prague. — The Association of Architects and Engineers of the Kingdom of Bohemia is making preparations at Prague for an exhibition, from 17th to 26th March next, of industrial products, especially of novelties connected with electricity. Foreign contributions are admissible, and no charge is made for space, which must be applied for before 1st March, at the Architekten- und Ingenieur-verein, 55, Wenzelsplatz, Prag.

Electric Safety Lamps.—A prize of £500 is offered by Mr. Ellis Lever, of Manchester, for the most perfect portable miners' lamp for underground use. A committee has been appointed by the Miners' National Union, to decide the conditions to be fulfilled, investigate the claims of competitors, and ultimately award the prize. It is expected that this offer will lead to an exhibition of miners' safety lamps.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

January 24.—"The Suez Canal." By Lieut.-General Rundall.

January 31.—"Ensilage in the United States." By Prof. J. E. Thorold Rogers.

FEBRUARY 7.—"The Modern Lathe." By J. H. EVANS.

FEBRUARY 14.—"Some Points in the Practice of the American Patent Office." By SIR FREDERICK BRAMWELL, F.R.S. R. E. WEBSTER, Q.C., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at 8 o'clock :—

JANUARY 30.—"Life among the Turcoman Nomads." By EDMOND O'DONOVAN.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings at Eight o'clock :—

JANUARY 25.—"Technical Aspects of Lignification." By C. F. CROSS, F.C.S. Prof. H. E. ARMSTRONG, F.R.S., will preside.

CANTOR LECTURES.

Monday evenings at Eight o'clock :—

Second Course, on "Solid and Liquid Illuminating Agents." By LEOPOLD FIELD.

LECTURE I.—JANUARY 29.

Introduction. Classification of fatty bodies; chemical relationship; ubiquity of their sources. History of lighting. Ancient appliances.

LECTURE II.—FEBRUARY 5.

Primary, or unmanufactured materials:—Tallow and Lard. Bee, Myrtle, Japan, and other Waxes. Spermaceti. Palm and Cocoanut oils. Candles from the foregoing. Night-lights.

LECTURE III.—FEBRUARY 12.

Colza, Olive, Whale, Sperm, and Fish oils. Mineral oils. Lamps:—The Argand, Moderator, Duplex, and Silber methods. Flashing points. Government restrictions.

LECTURE IV.—FEBRUARY 19.

Secondary, or manufactured products. Chevreul's discoveries. Fatty acids; their formation by saponification, distillation, and pressure. Glycerine. Collateral benefits accruing from the Palm oil trade.

LECTURE V.—FEBRUARY 26.

Paraffin. History and sources. Outlines of the chief processes of manufacture. Coal-tar products. Paraffin oil. Naphtha. Petroleum.

LECTURE VI.—MARCH 5.

Ozokerit, and other mineral sources of light. Manufacture of Candles. Survey of the candle trade and the various inventions and industries excited thereby. Conclusion.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 22....Society of Engineers, 6, Westminster-chambers, S.W., 7½ p.m. Mr. A. T. Walmsley, "Land Surveying and Levelling." (Lecture III.)
British Architects, 9, Conduit-street, W., 8 p.m. Mr. W. Simpson, "Architecture of the Himalayas, with Notes upon some Thibetan Buildings."
Medical, 11, Chandos-street, W., 8½ p.m.
Asiatic, 22, Albemarle-street, W., 4 p.m. Mr. H. H. Howard, "The Northern Frontages of China, the Hia or Tangat."
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. F. Harrison, "A Few Words on the 18th Century."

TUESDAY, JAN. 23...Royal Institution, Albemarle street, W., 3 p.m. Professor W. C. Williamson, "Primæval Ancestors of Existing Vegetation." (Lecture II.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on Mr. William Anderson's Paper, "The Antwerp Water Works." 2. Mr. John Fernie, "Mild Steel for the Fire-boxes of Locomotives in the United States."
Science Society, King's College, Strand, W.C., 8 p.m. Mr. E. Horne, "Wind Pressure and Wind Measurement."
Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. Annual Meeting.
Royal Colonial, the Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Sir William Fox, "A Chapter in the History of New Zealand."

WEDNESDAY, JAN. 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Lieut.-General Rundall, "The Suez Canal."
Geological, Burlington-house, W., 8 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

THURSDAY, JAN. 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Mr. Charles F. Cross, "The Technical Aspects of Lignification."
Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Annual General Meeting. Reading of Paper, and Discussion.
London Institution, Finsbury-circus, E.C., 7 p.m., Dr. W. H. Stone, "Singing, Physically and Physiologically Considered."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Spectroscope and its Applications. (Lecture II.)
Inventors' Institute, 4, St. Martin's-pl., W.C., 8 p.m.
Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

FRIDAY JAN. 26...Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Annual General Meeting. Reading of Papers and Discussions.
Royal United Service Institution, Whitehall-yard, 3 p.m. Sir Samuel White Baker, (1) "Cyprus as a Naval and Military Strategical Position;" (2) "Steel Bullet-proof Cart Shield for the Protection of Field Batteries."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m., "Mr. G. Romanes's Recent Work on Star Fishes."
Quekett Microscopical Club, University College, W.C., 8 p.m. Mr. J. G. Waller, "An Undescribed Sponge of the Genus *Hymeraptria*."
Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, JAN. 27...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Dr. F. Guthrie, "Liquid Slabs." 2. Prof. G. Carey Foster, "The Absolute Measurement of Electrical Resistance." 3. Mr. W. Baily, "The Spectra formed by Curved Diffraction Gratings."
Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. Bosworth Smith, "Episodes in the Life of Lord Lawrence." (Lecture II.) Henry and John Lawrence, 1849—1857.

Journal of the Society of Arts.

No. 1,575. Vol. XXXI.

FRIDAY, JANUARY 26, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PREMIUMS FOR THE 129th SESSION.

John Stock Prize.

Under the will of John Stock (1781), funds were bequeathed for the promotion of "Drawing, Sculpture, and Architecture."

A Society's Gold Medal, or £20, is now offered for the best design, from a poem, or from history, or from the Scriptures, prepared with a view to Mural Decoration.

Benjamin Shaw Prize.

Benjamin Shaw, in 1879, presented the Society with a sum of money, the interest of which is applied to Prizes for "Industrial Hygiene."

Under this trust, the following two prizes are now offered:—

1. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the operations of coal-mining."

2. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the manufacture, storage, and transport of explosives."

*** The Council leave it to the competitors to bring the plans under their notice in any way they may think proper, whether by model, written description, or otherwise.

Howard Prize.

Under the will of Thomas Howard (1868), funds were bequeathed for the periodical award of a prize for an Essay on Steam or Motive Power, or for an invention connected therewith. A prize of £100 is now offered for the best Essay on the Utilisation of Electricity for Motive Power. Preference will be given to that Essay which, besides setting forth the theory of the subject, contains records with detailed results of actual working or experiment. The Society reserves the right of publishing the prize essay.

Fothergill Prize.

Under the will of Dr. Fothergill (1821), funds were bequeathed for the offer of Medals for subjects, in the first instance, relating to the Prevention of Fire. A Society's Gold Medal, or £20, is now offered for the best Invention having for its object the Prevention or Extinction of Fires in Theatres.

Mulready Prize.

The Council of the Society hold certain funds, balance of the amount subscribed for a Mulready Memorial, the interest of which is to be expended (amongst other purposes) in providing, occasionally, a medal to be awarded "To that student in a School of Art in the United Kingdom who exhibits the best Drawing from the nude figure, executed in black and red chalk, in the manner so successfully practised by Mulready."

A Society's Gold Medal is now offered under the above conditions.

Designs, plans, models, essays, descriptions, inventions, &c., intended to compete for any of the above Prizes, must be sent in on or before the 31st October, 1883, to the Secretary of the Society of Arts, John-street, Adelphi, London.

The Council reserve the right of withholding any or all of the above Prizes, or of awarding others of lesser value in their stead, in any case in which there is nothing in their opinion deserving the award, or sufficiently complying with the conditions, sent in for competition.

H. Trueman Wood,
Secretary.

Proceedings of the Society.

EIGHTH ORDINARY MEETING.

Wednesday, January 24, 1883; Sir John Hawkshaw, F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Annett, Richard Charles Francis, Llanwddyn, near Llanfyllin.
Bain, F. E., 12, Park-row, Hampstead, N.W.
Blackstone, Joseph, 6, Albert-terrace, Regent's-park, N.W.
Dacie, John, Soap and Candle Works, Putney, S.W.
James, Richard, H.M. Dockyard, Chatham.
Jennings, James, Marton Grove-house, Middlesbrough.
Knight, John Baillie, Silvertown Soap Works, E.
Moore, Joseph, The Mount, Sevenoaks.
Newton, Francis Murray, M.A., 82, Packenham-place, Dublin-road, Belfast.
Nunn, John Hancock, Norman-house, Hornsey, N.
Supp, Arkas, J.P., Basingstoke.
Upton, Henry, Marlborough-club, Pall-mall, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Bruce, Eric Henry Stuart, M.A., Glenelg, Bournemouth, Hants.
Byrne, Samuel Henry, Brighouse, Yorks.
Cotton, William F., Mountainville, Dundrum, Co. Dublin.
Harrison, Colonel Richard, R.E., C.B., United Service Club, Pall-mall, S.W.
MacKenzie, James Kenneth Douglas, 27, Sussex-gardens, Hyde-park, W.
Smith, Frederick John, B.A., Mary-street-house, Taunton.

The paper read was—

THE SUEZ CANAL: ITS ENGINEERING, COMMERCIAL, AND POLITICAL ASPECTS.

By Lieut.-Gen. F. H. Rundall, C.S.I., R.E.,
Late Inspector-General to the Government of India.

The Suez Canal has of late occupied, and is still occupying largely, the attention of all Europe—and, perhaps it may not be too much to say, of the whole civilised world. At the same time, notwithstanding so much has been written and talked about it, beyond the fact of its being the great thoroughfare to India for the ships of all the Western nations, but little comparatively regarding it is known to the public generally.

The mercantile world, and those more particularly interested in the Canal, can of course obtain from the Parliamentary Blue-books a mass of important information and statistics not otherwise available, more especially as regards the official negotiations which have passed between the various Governments in reference to the commercial and political aspects of the undertaking. But Blue-books are not attractive reading, even to those who have leisure, while business men seldom have time sufficient to devote to their study. The Society of Arts, therefore, being desirous of procuring a succinct, and at the same time correct, and comprehensive, account of the Suez Canal in all its aspects, an endeavour is made, in the following remarks, to meet that desire, by collating, from official and other publications, the most important of the particulars available, and, at the same time, to consider the various bearings of a question which is now attracting such universal attention, and which is generally felt to be of primary importance to England at the present time.

The Suez Canal has to be viewed in three aspects:—

1. As an Engineering work.
2. As a Commercial undertaking.
3. As a Political problem.

Before commencing to discuss these three points in detail, I propose to give a short history of the scheme, from the period of its first incubation, to its present stage of development.

The first idea, in modern times, of connecting the Mediterranean with the Red Sea seems to have originated with Napoleon I., but before he could give any practical shape to that idea, the Emperor had to evacuate Egypt.

Nothing further was attempted till the year 1842, when Captain James Vetch, of the Royal Engineers, published a pamphlet, in which he indicated the direction a canal should take across the Isthmus, and its vast importance to this country; but the Government of the day were opposed to the construction of any canal, and Captain Vetch's suggestions fell to the ground. Subsequently, in the year 1846, a Commission of engineers assembled to discuss certain proposals, which, however—beyond exposing the error as to a difference of level of thirty feet between the Mediterranean and Red Sea—came to nothing, and so the subject dropped until 1854, when it was revived by Monsieur de Lesseps putting forward his project for a direct canal between the two seas. His proposals met with considerable opposition in England, strangely enough from commercial authorities, who foresaw the total revolution that would be made in the carrying trade, but who were apparently unable to appreciate or believe in the enormous advantage that would accrue to them from such a revolution. But there was likewise a formidable political opposition, based on certain objections which

the Government of the day foresaw would, unless duly safeguarded, be likely to give rise to considerable difficulties in the future. That those objections were not destitute of foundation, every statesman of the present day will readily admit; and the difficulties which are now attendant on current negociations only too plainly indicate that a scheme which at first apparently concerned only a small body of speculators, has turned out to be a political problem, perplexing, more or less, the whole continent of Europe; but the difficult task of solving which has, by a general consensus of opinion, devolved, and rightly so, upon England.

This phenomenon is not without its prototype. Our Eastern Empire, as is well known, had its first beginnings in the ventures of a few enterprising merchants, whose marvellous prosperity, in spite of themselves, raised the East India Company to the highest importance as a political factor, stimulated its acquisitive energy until its operations got beyond control, and the Merchant-princes of the East found themselves overturned in the great convulsion which, in 1857, shook the Empire to its foundations, and so nearly involved the whole of the gigantic fabric in ruins. It is, to say the least, a curious coincidence that ere India had recovered from the throes of that convulsion, an enterprise like the Suez Canal, originated by private speculators, and the interests and prosperity of which are so closely dependent on those of India, should be started into existence, and, after nearly foundering, should, in a brief time, enter on such a career of prosperity, become a link between gigantic interests, and in its turn rise to be an important factor in the political world; and what is stranger still, instead of proving, as was anticipated, a spear for piercing its armour, it has been converted into the first line of defence for England—a veritable covered way for safe-guarding its Eastern possessions! Is the parallel to be pursued any further? Doubtless the projector would exclaim, "*Dii omen avertant!*"

But to return to the history. In 1859, Monsieur de Lesseps' scheme was actually begun, and after successfully combating many difficulties, both physical and political, the Canal, though incomplete, was finally opened from sea to sea ten years afterwards, in the year 1869, with great pomp and ceremony, in the presence of a brilliant Imperial assemblage. From 1869, to the present time, the Canal has been in constant use, without a day's intermission. Its career has not been altogether unchequered; but it has emerged from its difficulties, and has now reached a pitch of prosperity exceeding the most sanguine expectations of its projector.

To pass on to the consideration of the Canal as an engineering work. It is unnecessary, as well as out of place here, to enter into minute details of construction, and therefore only its more general features will be brought under review. There is little room to doubt but that the engineers who were entrusted with the surveys, selected, on the whole, the most favourable line for the Canal, as regards economy of first construction. The entrance from the Mediterranean is between two long piers, or moles, run out from the coast, with the idea partly of creating a species of harbour, in which vessels approaching the Canal might lie in quiet water. The western mole, however, was also intended to serve as a protection against the entrance becoming silted by the Nile deposit, which is transported during the floods of that river in enormous quantities along the coast for many miles.

It may be open to comment whether, instead of placing the entrance from the Mediterranean at Port Said, it might not have been better made more to the eastward, and further removed from the influence of the silt-laden waters of the Nile. It is said that the difficulties connected with the silt deposit at that entrance have been overcome, but that assertion must be received with caution; for it is quite certain that the coast line between the Damietta mouth and near the Canal has advanced considerably, while the 5-fathom line had receded, as noticed in Sir John Stokes's Report in 1874, 1,200 yards in three years. The diagram on the wall, is on too small a scale to show the present position of that line, and the rate at which the intervening space is being filled up, or how far the statements of Monsieur Lemasson, the French engineer, are borne out, as to the effect that a deposit of $7\frac{1}{2}$ million cubic metres per annum was likely to produce. The western mole has, it is believed, now reached a length of nearly 3,000 yards, and to where the 5-fathom line used to lie. Of course, as deeper water is reached, the process of silting up will become slower, but that it cannot be wholly arrested by mere extensions of the western pier, though accompanied by dredging, is incontrovertible. Hence it may be admitted that the further the entrance could have been removed to the eastward, the less inconvenience would have been

experienced from the translation of the Nile deposits.

With the exception of some unnecessary curves, especially that near the town of Ismailia, the general alignment of the Canal is satisfactory; but since the traffic began to increase, the mistake of making those curves has become apparent. It must be admitted, however, that the mistake has been aggravated rather by the continually increasing length given to vessels which have been (and are still being) built for the navigation of the Canal.

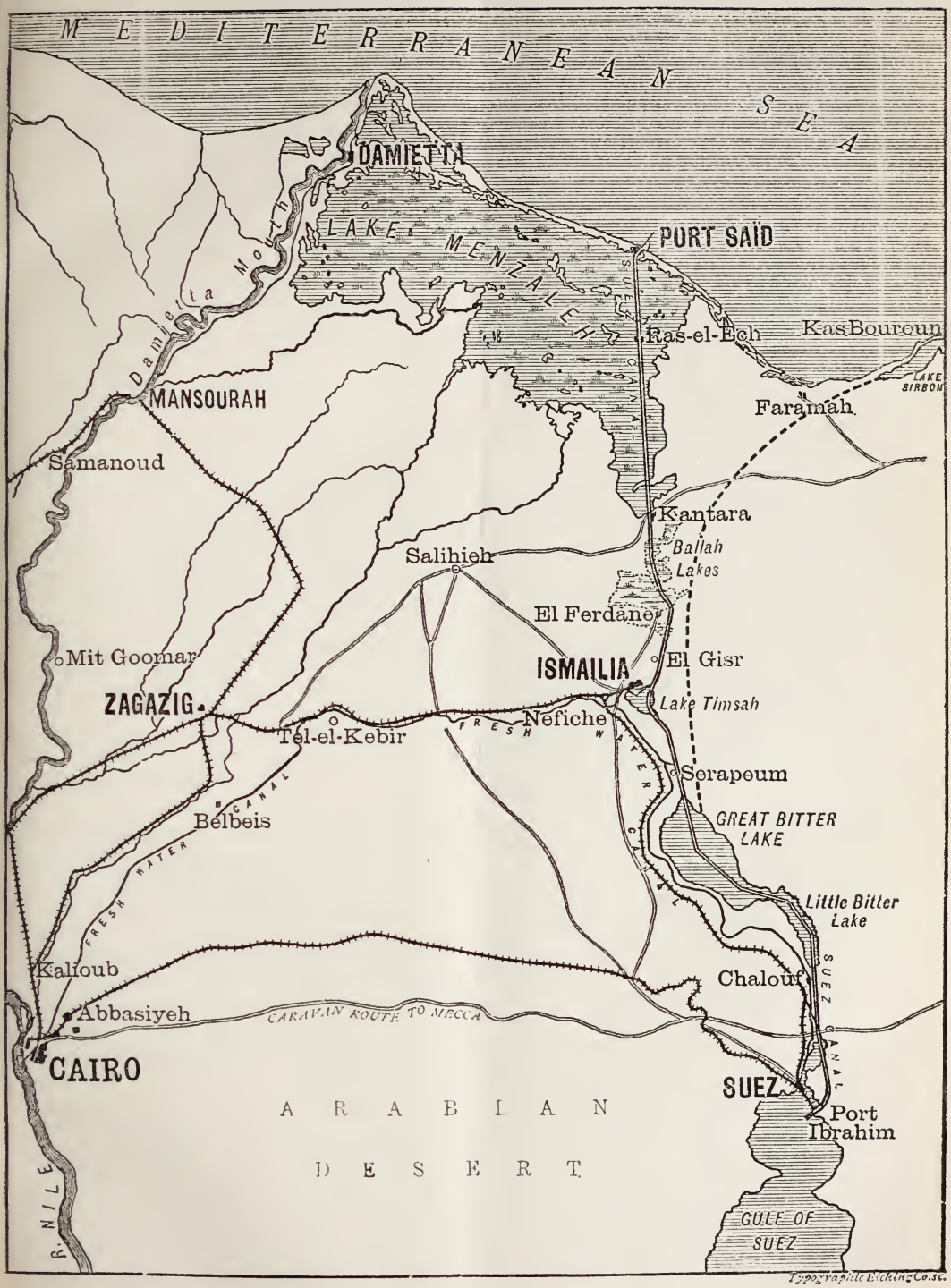
The total length of the line from Port Said to Suez measures 88 geographical, or 100 land miles, of which 39 miles only are in cuttings through land, the other 61 miles rnnning through a succession of lakes. The northern half of the Canal, as far as Lake Timsah, had to be excavated by manual labour, until sufficient depth could be obtained to admit of dredging operations; but the portion south of Lake Timsah was excavated entirely by dredgers, as water was obtained on a high level from the Freshwater Canal, which had, meanwhile, been constructed; and thus by filling up the line of the Suez Canal to that level, sufficient depth was obtained for floating the dredgers. At El Guisr, Serapeum, and the Chalouf plateaux—in all, about eighteen miles of cutting—rock (more or less hard) was encountered, rendering excavation both difficult and costly, as blasting operations had to be resorted to. Though along the rest of the line the material to be excavated consisted principally of sand, with an occasional admixture of clay, yet the task of not only excavating soil to a depth of 26 feet below water, but of conveying it away, involved some difficulty, which was finally overcome by some very ingenious adjuncts and appliances to the ordinary dredgers. The excavated material could not, as in the case of river or harbour dredging, be simply lifted into hopper barges, and be towed out and discharged into the sea; it had to be deposited on banks on either side, the height and breadth of which were, of course, continually increasing.

According to Lieut.-Colonel (now Sir A.) Clarke's report, written in February, 1870, it was originally intended to construct the Canal with a surface width of 325 feet, and a bottom width of 144 feet; but the latter, at the present time, does not average more than 70 feet. The side slopes, which vary according to the soil passed through, are being now faced with stone, by which means a considerable length of the Canal is protected from the erosion which used to take place from the wash of the steamers.

A minimum depth of 26 feet is maintained throughout the Canal. The bottom width being only half that originally intended is, of course, insufficient to allow of vessels passing one another, and obliges a low speed to be maintained.

Sir John Stokes observes, in a report dated 20th April, 1876, that, in his opinion, the narrow width is not altogether a disadvantage, inasmuch as by necessitating the Canal being worked on the block system the risk of collision is greatly reduced, and the passage of vessels is, in the long run, performed in a shorter space of time than if vessels were allowed to navigate independently. Unquestionably, the risk of collision is especially to be avoided where large vessels are concerned, for the momentum of masses 2,000 to 4,000 tons in weight, moving even at a low velocity, is exceedingly great, and when brought into collision must be attended by disastrous results. But the narrowness of the section operates disadvantageously in retarding the speed of vessels below the economical unit. When the difference between the sectional area of the Canal and that of the vessel's midship section is so small, the piling of the water caused by the vessel's displacement is greatly increased; the friction on the sides of the vessel, as well as on those of the Canal, so retards the flow of the water that the void created by the vessel's onward movement cannot be filled sufficiently fast, and hence the steering power is destroyed, and the ship either takes the ground astern or runs bow on to the bank.

By experiment on the Indian canals, it was found that when the relative sectional area of the vessel and canal were in the proportion of from 1 to 12 or 14, with a depth of 3 to 4 feet under the steamer's keel, there was no perceptible piling, and a speed of from 8 to 10 miles an hour could be maintained, but wherever that relative proportion fell short, piling began to take place, and the speed was proportionately diminished. If, therefore, the Suez Canal were finished more nearly to its original dimensions, or, say, to 320 on the water line, and 200 at the base, with slopes of 2 to 1, it would, if 30 feet deep, contain a sectional area of 7,800 square feet, and yield a proportion of 13 to 1 to all vessels whose midship section did not exceed 600 square feet, and which would probably include all ships registering 2,000 tons. The block system, if



Typographic Etching Co. sc.



found absolutely necessary, might still be maintained, but it would give the opportunity for such vessels to accomplish the passage of the Canal in twelve hours of daylight. The narrowness of the bottom width of the Canal not admitting of large vessels passing one another, side-cuttings, called "Gares" or stations, have been made at intervals of five miles, wherein large vessels can lie moored during the night, or whenever the necessity may arise. As observed before, the method of working the Canal is that known on railways as the block system, no vessel being allowed to proceed from one station to another until the line is signalled clear, for which purpose a perfect telegraphic communication is kept up through its entire length. The arrangements for carrying this out are described in Sir J. Stokes's report, as follows :—*

"Each of the superintendents of the transit at Ismailia, Suez, and Port Said has a model of the Canal in his office, with miniature vessels, which enable him to fix the position of each ship as it passes through. As soon a vessel enters the Canal, either at Suez or Port Said, its counterpart is launched on the models with name affixed. As it passes each siding, which is also a telegraph station, its position is made known to the superintendents, who fix its place on the model, and the chief transmits orders for the guidance of the pilot on board. Then, whenever a vessel approaches a siding, it finds a signal directing its movements, whether it is to remain or move: if to remain, the orders are strict that it is to make fast to the bank in the siding, and to leave the navigable channel quite free."

If these orders are acted up to, it is impossible for two vessels to meet in the section between two sidings, and so collision is rendered impossible. The Canal is also furnished with every accessory in the shape of light-houses, beacons, buoys, telegraphs, &c., for facilitating the navigation as far as possible.

It would have been impossible to carry on the work of the Maritime Canal without a supply of fresh water, which was wanting along the whole line. The company was therefore empowered by the Egyptian Government to construct a canal for irrigation and navigation from the River Nile, at a point below Cairo, to Timsah, and thence to furnish a supply for the towns of Port Said and Suez. This canal has since been enlarged and completed with locks, and is the work which proved of such invaluable aid in the late military operations in Egypt. The extensive tract of land granted to the company, and for which irrigation had to be supplied, was subsequently taken back by the Government, and the company empowered only to use the water for domestic purposes.

So far, then, as an engineering work, it would leave little to be desired, had vessels of the type in vogue before its construction continued to be used. But as the science of ship-building progressed, it has been found possible and necessary, in order to keep up with the requirements of trade, to construct vessels of much larger dimensions, and on different lines; and, consequently, ships have outgrown the existing dimensions of the Canal, and demand increased accommodation. It has been seen that the original intention was to construct the Canal of double the present dimensions, but the financial necessities of the company prevented them from carrying out that intention. Though forced upon them, the course adopted was quite the right one; for the Canal, on the smaller scale, has thoroughly served its purpose for thirteen years; and now that it is placed in a highly satisfactory and flourishing financial condition, the time has arrived when additional capital may prudently be laid out, to increase the accommodation which a rapidly increasing trade demands. The best means of providing additional accommodation is still a matter under consideration, notwithstanding certain measures have been publicly announced in some of the daily papers as having been definitely settled. Probably the company, finding that it will be to their own interests not to postpone any longer meeting the demands made upon them, have decided on carrying out meanwhile certain obvious improvements; but the larger and more permanent provision, that must sooner or later be made, has yet to be settled. The possible alternatives that present themselves will be explained hereafter. Meanwhile, there only remains to be noticed, under this head, the items of cost of original construction, repairs, and supervision. The total capital expenditure up to 1869, the year in which it was opened, amounted to £18,000,000. The sum spent annually on repairs and improvements carried out from revenue, does not vary very much, amounting, in 1880, inclusive of supervision, to £218,900; and, in 1881, to £212,490, thus averaging less than 1¼ per cent. on the first cost—a very moderate and satisfactory outlay.

Passing on now to consider the Canal in its second aspect, as a Commercial undertaking,

* *Vide* Blue-book, Commercial, No. 10, 1874, p. 146.

there is much of a very interesting character to be explained. The first fact is one which, outside official circles, will probably be entirely new to 99 persons out of 100, and that is that La Compagnie Universelle du Canal Maritime de Suez (The Universal Suez Maritime Canal Company) is not a French but an Egyptian company, having its principal office at Alexandria, amenable to the laws and customs of not the French but of the Turkish Empire, and, therefore, subject to the jurisdiction of its local tribunals. The importance of this fact will be sufficiently evident, when the disputes which subsequently arose between the directors of the company and the Egyptian and Turkish Government come to be noticed. It is not too much to add that, but for this precaution at the time of the formation of the company, it would not only have been impossible for the nations of Europe to make use of the Canal, but that the subsequent attempted exactions of the company might have led to very serious misunderstandings, if not to actual embroilments, amongst some of the European Powers. Before proceeding, however, to explain the more especial commercial features of the Canal, it is necessary to draw attention to the nature and terms of the various "concessions" granted by the Egyptian Government, and subsequently ratified in a firman by the Sultan as suzerain. Eight concessions were granted by the Viceroy of Egypt between the years 1854 and 1869, the details of which have been published in the Parliamentary Paper, "Egypt, No. 6 (1876)." In the first of these, dated Nov. 30th, 1854, the Viceroy confers on Monsieur de Lesseps, "exclusive power to form and direct a universal company for piercing the Isthmus of Suez, and the working of a Canal between the two seas within, and subject to certain specified restrictions and conditions," the most important of which, as regards the constitution of the company, were:—

1. That the director of the company was to be always named by the Egyptian Government, chosen, as far as possible, from amongst the shareholders most interested in the undertaking.

2. That the duration of the concession was to be for 99 years from the date of the opening of the Canal throughout.

3. That the Government reserved to itself the power to erect any fortifications it pleased in the neighbourhood.

4. That the Egyptian Government were to receive, yearly, 15 per cent. of the net profits shown in the balance-sheet of the company, without prejudice to any dividends belonging to the shares which the Government reserves a right to take on its own account, and without any guarantee on its part.

6. That the rest of the profits were to be divided as follows: 75 per cent. for the benefit of the company; 10 per cent. for the benefit of the original promoters.

7. That, on the expiration of the concession, the Government to succeed to the company, enjoy all its rights, and enter into full possession of the Canal.

8. That no alteration could be made in the statutes of the company, without receiving the previous approbation of the Viceroy.

The second concession, dated 5th January, 1856, is an amplification of the first one, explaining, in more detail, the nature of the charges and concessions, the most important of which are:—

1. The limitation of the power of the company to carry out a canal east of the Nile, from the Gulf of Pelusium, and authorising the construction of a fresh-water canal from Cairo to Lake Timsah.

2. The solemn declaration of the Viceroy, subject to ratification by the Sultan, of the Maritime Canal and its ports being always open as neutral passages for all merchant ships on payment of dues, without preference to any vessel, company, or person.

3. The dues on vessels navigating the Canal not to exceed 10 francs per ton of capacity and per head of passengers.

This concession was made over to Monsieur de Lesseps, previous to ratification by the Sultan, to enable him to constitute the financial company. Amongst the statutes of the company approved by this concession was one appointing its seat at Alexandria, and its administrative domicile at Paris.

The statutes direct that the annual proceeds were to be applied in the following order:—

1. To expenses of maintenance, working and administrative, and generally all charges of the society.

2. To interest and sinking fund of such loans as might be contracted.

3. Five per cent. on capital of society to be applied to provide for shares redeemed and not redeemed, and an annual interest of 25 francs per share; the interest attributable to shares redeemed being carried to the sinking fund.

4. Four hundredths per cent. on the capital to be applied to the sinking fund.

5. To the amount required for creating and keeping up a reserve fund for unforseen expenses. The excess over the above proceeds to constitute the net profits, which were to be distributed as already stated.

Concession No. 3, dated 6th August, 1860, is a financial agreement containing the first settlement of accounts with the Egyptian Government respecting its subscription; and,

in March, 1863, concession No. 4 contained another financial agreement for settling the balance payable on shares subscribed for by the Egyptian Government.

At this period intervenes an important Act by the Porte, which perceiving in the concession of the fresh-water canal, and of vast tracts of land, a menace to its independence, and in the stipulations for the providing of workmen, a violation of the laws under which the Ottoman Empire is governed, declared by a diplomatic note, dated 6th April, 1863, addressed to its representatives in Paris and London, its opposition to the continuance of the works. The same notification was made to the Viceroy, who communicated it to Monsieur de Lesseps, expressing his intention to treat on and settle these questions with the company, and accrediting Nubar Pasha to come to an understanding on the proposals to be submitted. The Council of Administration rejected the proposals, and then the Khedive begged the intervention of the Emperor of the French, who, after receipt of the report of the Commission which he appointed to examine into the questions involved, gave his decision; awarding to the company a sum of 84 millions of francs, or £3,360,000, the payment of which was to be spread over a period of 15 years, ending with 1st Nov. 1879.

Consequent on this award, a sixth convention was drawn up, dated 30th January, 1866, in which the following important Articles occur:—

1. Egyptian Government to keep all strategical points.

2. Power for the Government to occupy sites for post-offices, customs, barracks, and other services.

4 and 5. The Government to take possession of the fresh-water canal, on the terms specified.

A further agreement was drawn up in the following February, and received the sanction of the Sultan in a firman, dated 19th March, 1866, which stated the conditions to which such a sanction was subjected. One important Article being to the effect that—

"The Maritime Canal and its appurtenances remain subjected to the Egyptian police, which shall exercise its functions freely, as at every other point of the territory, so as to secure good order, the public peace, and the execution of the laws and regulations of the country."

In Article 16 occur the words:—"The Universal Company of the Maritime Canal of Suez, being Egyptian, it is governed by the laws and usages of the country;" and the Articles which follow declare its complete subjection to the Egyptian Government. Two agreements, dated 23rd April and 26th January, 1869, complete the negotiations prior to the opening of the Canal, and in them is the arrangement by which the Viceroy assigns fifty coupons from each of the 176,662 shares belonging to the Egyptian Government, for the space of twenty-five years, in settlement of the 30,000,000 francs, the value awarded for the resumption of the fresh-water canal from the company.

The recapitulation of the concessions, though somewhat tedious, is essential to the right understanding of certain events which occurred shortly after the opening of the Canal, as also of the obligations that regulated the amount of dividends which the company paid to the shareholders, as well as of the status of the company generally.

Turning now to the cost of the Canal, already stated to be £18,000,000, it appears that of this, the amount of capital originally subscribed was only £8,000,000, in 400,000 shares of £20 each. That amount was subsequently augmented by the loan of 1867 for £4,000,000, being debentures ("obligations") redeemable in fifty years, bearing 5 per cent. interest, and having a first charge on the profits. After these, the loans of 1871 were contracted by the issue of thirty years bonds, bearing 6·7 per cent. interest, which, in their turn, were succeeded by £1,360,000, representing consolidated arrears of interest on ordinary shares, in the shape of seven coupons of 5 per cent. yearly. Lastly, came the advance on detached coupons of the Egyptian Government shares amounting to £1,200,000, styled "delegations," and entitled, for twenty-five years, to 5 per cent., and a dividend (if any) on those shares. The balance of the cost of the Canal was made up from the indemnities which had been paid by the Khedive under the late Emperor's award. In 1870, the year after the opening of the Canal, the prospects of the company being doubtful, a suggestion was made by the Khedive that it should be transferred to some English company.

The negociations which followed this suggestion belong rather to the political than the commercial aspect of the Canal, and will be better adverted to hereafter.

The doubtful prospects of the company, however, led to a very objectionable proceeding on the part of the Board of Administration, viz., in determining arbitrarily the interpretation of the term, "ton of capacity," on which the authorised due of ten francs was

leviable. That due had been, for the past three years, levied on the net register tonnage, as shown in the ship's papers, and calculated on the Moorsom system, which, after reckoning the gross tonnage of the ship, deducted the space occupied by the engines, fuel, &c. The term, "ton of capacity," not having, however, been actually defined at the outset, the company took upon themselves to interpret that term as signifying the "real capacity" of the ship, which, by a commission of their own appointment, they declared to be greatly in excess of the net register tonnage, the result being that the dues were levied on the gross tonnage, and consequently the tolls payable by every ship traversing the Canal were raised 30 per cent. The burden of such an interpretation at once made itself felt in the case of steamers, in which the machinery occupies one-third of the tonnage, and was therefore equivalent to levying 50 per cent. more from steamers than had been levied in the three previous years. Remonstrances were immediately put forward by the principal maritime companies in England, and the Messageries Nationales actually brought an action against the Canal Company in France. A decree was at first given in their favour, but it was afterwards reversed on appeal.

The protest, however, of the British Government led to the assembly of an international Commission at Constantinople, and to the adoption of a style of measurement according to what are known as the Constantinople Rules. It was not, however, without great discussion, in which the tact and firmness of the English delegates, Sir John Stokes and Sir P. Francis, were eminently conspicuous, that the proceeding of the Canal Company were set aside, and the Moorsom system of measurement declared to be correct, and adopted accordingly.

Finding themselves entirely in the minority, the French delegates eventually joined in signing the report of the Commission, which set forth the rule to be followed in the measurement of vessels, and the deductions to be made in order to arrive at the net tonnage. As a set-off, however, against the diminished revenue which it was supposed would follow the first introduction of the new rules, the Commission recommended permission being given to the company to levy temporarily a graduated surtax of 3 francs per ton on vessels provided with the prescribed certificate of net tonnage measurement, on condition that the deduction did not exceed 50 per cent.

Vessels not measured according to the Moorsom system were to have their tonnage reduced by calculation to the scale of the Danube, and to pay a surtax of 4 francs per ton, as also vessels measured according to Section A, Clause 23, of the British Merchant Shipping Act of 1854.

The surtax of 3 francs to be reduced in the following proportions:—To $2\frac{1}{2}$ francs per ton, as soon as the net tonnage passing through the Canal reached 2,100,000; to 2 francs when it reached 2,200,000; and so on, $\frac{1}{2}$ franc for each annual increase of 100,000 tons up to 2,600,000 tons, at which figure the surtax was to cease altogether, and the original due of 10 francs per ton only to be levied. Vessels of war, transports, and vessels in ballast to be exempt from the surtax.

The Porte was pleased to approve of the report of the Commission, and desired the Khedive to inform the company of the same, and direct it to be put in force in three months time.

Monsieur de Lesseps first protested, and then refused to accept the new rules; but, as in the event of his persisting in his refusal the Canal was to be seized by the Egyptian Government, he submitted, but under a protest, which was not withdrawn till some years afterwards.

Towards the close of the following year a rumour got abroad that a project was on foot to purchase the shares of the Canal Company belonging to the Egyptian Government. This led to the correspondence which is given in detail in Parliamentary Paper, Egypt, No. 1 (1876), and which ended eventually in the purchase of those shares, 176,602 in number, for a sum of £4,000,000.

In 1876, after the purchase had been concluded, and in consequence of a new convention, the company withdrew all opposition, accepted all that had been laid down by the Constantinople Commission, and agreed to the decrease of the surtax at fixed dates, and to its total abolition in 1884, and consented to expend one million francs per annum for thirty years in improving the Canal. That convention, which is known as the Stokes-Lesseps convention, has consequently been in force up to the present time.

It is time, now, to turn to that part of the subject which possesses the greatest interest for the English public, and that is the traffic passing through the Canal, and the revenue derived therefrom; for it indicates not only the relative importance of the Canal to the several nationalities which make use of it, but

it incontestably proves that were it not for the trade carried by British vessels, the Canal company must, long ere this, have entirely collapsed, and were it now to be withdrawn through any other channel, the Suez Canal could not possibly be maintained.

Seven years ago, an interesting paper was read before the Society, by Mr. Charles Magniac, on the "Commercial Aspects of the Canal," in which, on the whole, he took rather a depressing view of the prospects of British trade at the time, saying:—"That the returns up to that time showed that the great expectations entertained of a large increase of trade due to the canal, had not been borne out;" "that the imports into India were feebly stationary;" "that the falling off from France was immense, but greatly due to the effects of war;" "that the item most deserving of attention was that of the Mediterranean ports."

Similarly, in regard to the exports, the United Kingdom told the same story of stagnation, and it was only the Mediterranean ports that showed a buoyant and increasing trade, and that principally in the staple articles of Indian produce. But he summed up his description with the words, "Whatever we may say or do, however much industries or individuals may suffer at first, one thing we do know, that India has been brought within three weeks journey of England. We gained our supremacy there when a letter and its reply were frequently 12 months on the road. The same thing can now be done in 12 minutes. Is it to be supposed that this energetic nation will not find its advantages in such facilities as these? I am sure it will, and that even many here will live to see it." Mr. Magniac has doubtless ere this already satisfied himself of the verification of his prediction; but as possibly many are present who have not had the same opportunity, I propose briefly to call attention to the figures in the several tabular statements of the trade of India with England and the world generally, obtained from published official records of the Indian Government.

First, in regard to the imports of the United Kingdom; these show a steady increase from 1874, when they stood somewhat over 29½ millions, to over 32 millions in 1879-80, with the exception of the previous year, when, in consequence of the depression caused by the famine, they fell just below 29 millions. In 1880-81 they rose to £41,300,000, or an increase of over 33 per cent. In the foreign trade, France increased from £362,400 to £705,600, and Italy from £334,000 to £576,000.

From the rest of Europe the import trade is insignificant. The export trade to the United Kingdom does not show a similar increase in value, owing to the great fall in prices, but an examination of the quantities exhibits a satisfactory progress, while the exports to the principal European countries is more marked as regards increase in value. France having risen from £3,134,000 to £6,500,000; Mediterranean ports—Italy, £1,400,000 to £2,781,000; Austria, 1,428,000 to £2,226,000.

In five of the most important staples, cotton, rice, seeds, tea, and wheat, the progress in exports has been as follows:—

	1876-77.		1880-81.	
	Quantity	Value	Quantity	Value
	cwt.	£.	cwt.	£.
Cotton, raw	4,557,914	11,746,184	4,541,539	13,241,734
Rice	19,548,731	5,742,540	26,769,344	8,971,661
Seeds	9,582,865	5,319,124	10,229,109	6,345,209
Tea.....	27,784,124	2,607,425	46,413,510	3,054,240
Wheat	5,583,336	1,956,333	7,444,375	3,277,942

Of the quantity, 4,541,539 cwts. of cotton 3,818,557 cwts. were taken by Europe; that is, 2,019,612 cwts. by England, 633,891 cwts. by Italy, 605,954 cwts. by France, and 559,100 cwts. by Austria.

Of the total quantity, 26,769,344 cwts. of rice, about half, or 13,582,300 cwts., were conveyed to Europe; of which, England and Malta took all but 300,000 cwts.

Of 10,229,109 cwts. of seeds, 9,705,200 were brought to Europe, nearly 5,600,000 cwts. coming to England, and 3,256,180 cwts. going to France.

Of the 46½ million pounds of tea, only one million went to the Australian market, all the rest being brought to England. In 1879-80, the price of tea was ruinously low, and a collapse in that industry was imminent; but happily, the Australian market was partially opened, and gave just sufficient stimulus to prices to avert disaster.

In 1875, only 1¾ million cwts. of wheat were shipped from India. In 1880-81, there were 7½ million cwts., of which England took 4,800,000 cwts., 1⅓ million went to France, and 790,000 cwts. to the rest of Europe,

The proportion of the whole trade which came to and left India by the Suez Canal, during the last five years, has been as follows:—

	Whole Trade.	*Viâ* Suez Canal.	Per. Cent.
1876-77	113,920,539	60,243,259	52·88
1877-78	126,252,968	68,380,719	54·16
1878-79	109,777,084	53,398,875	48·64
1879-80	122,068,908	63,033,231	51·64
1880-81	138,108,657	81,175,876	58·78

The imports from the United Kingdom into India constitute 82·08 per cent. of the whole, and 42·33 per cent. of the produce shipped from India. The import trade is thus practically monopolised by Great Britain, the reason being that the only articles which the people of India largely consume are English products, in which other nations have not at present the capacity of competing with her for the supply of foreign markets.

On the other hand, the reason of her taking a smaller proportion of the exports arises from some of the most valuable Indian produce being shipped to other countries—notably, opium to China and the Straits; indigo, hides, and seeds to France, Italy, and the United States.

From these figures, it will be readily gathered that the commercial interests of England have not suffered from the Canal, but, on the contrary, have been largely augmented, and that while India has benefited by the opening of additional markets in Europe, England has also gained largely, and still maintains, a virtual monopoly of the Indian market for the disposal of her own merchandise, the value of which, in 1880-81, amounted to over 41¼ millions sterling.

Passing on to the general trade through the Canal, a reference to the tabular statements will show that first, as regards the total tonnage, the number of vessels which passed the Canal in 1870 was 486, and the tonnage 435,911 tons. In 1879, the vessels numbered 1,477, and measured 3,236,942; that is, while the vessels had increased threefold, the gross tonnage increased more than sevenfold. In 1870, the vessels averaged 900 tons each; whereas, in 1879, the average size reached 2,180 tons. In 1877, however, the greatest number of vessels, viz., 1,663, passed through the Canal, but they only measured 3,418,950 tons, giving for the average of each vessel 2,056 tons. During the same period, the receipts of the company increased from £256,000 to £1,214,520. Great as that increase was, it is nothing compared to the increase within the last three years. In 1880, the vessels numbered 2,026, with a gross tonnage of 4,344,519 tons; and in 1881, the number rose to 2,727 vessels, measuring 5,414,050 tons.

Now, as to the nationalities of the vessels indicated in Table II. In the decade, ending 1879, out of 12,454 vessels, no fewer than 9,154, or three-quarters, were British; conveying 17,555,500 tons out of the total quantity, 23,105,535 tons.

In like manner, out of the 2,026 vessels in 1880, 1,592 were British, measuring 3,446,431 tons, out of a total 4,344,520 tons; and, in 1881, the British numbered 2,251 out of a total of 2,727 vessels, and the tonnage, 4,792,118, out of 5,794,400, thus increasing the proportion of vessels and tonnage from two-thirds to four-fifths. The trade of 1881, then, of vessels other than British, amounted to only 1,002,282 tons, and would, at 10 francs per ton, have yielded a revenue of only £400,915.

In 1880, the total expenditure on the Canal was about £218,900; interest and sinking funds of loan, £531,560; total, £750,460. So that, but for the British trade, instead of 13½ per cent. interest accruing to the original shareholders, there would not have been sufficient to pay even a moiety of the interest of the loans!

Similarly, with regard to the revenue realised. In 1879, it amounted to £1,214,520; 1880, £1,672,836; 1881, £2,187,047. The actual returns obtained from the Canal will be seen from the following figures:—

	£
In 1880, the expenditure on repairs was	218,898
Amount set aside for interest and sinking funds	531,559
To provide for the interest at 5 per cent. on share capital and sinking fund	403,215
Total	1,153,972
Which deducted from the total receipts	1,672,836
Leaves a balance of	£519,164

to be allotted to reserve funds, and other purposes, as enjoined in the statutes above quoted, after deducting the 15 per cent. appropriated to the Egyptian Government. Of this sum, £350,176 was divided among the original shareholders, raising their profits to 5 + 4·3 = 9·3 per cent.

In 1881, the cost of working the Canal was somewhat less than in 1880, viz., £212,490, while the interest and other charges remained about the same, but the total receipts were £2,187,047; so that the sum to be divided reached £700,856, and the original shareholders pocketed 5 + 8·76 = 13·76 per cent. By arrangement, a certain number of shares

are drawn to be paid off each year; those shareholders, therefore, who have got back their capital, cease to receive the annual 5 per cent. interest, but are entitled to the dividend of 8·76 per cent. on it, and will continue to receive the enhanced dividend, whatever it may amount to, till the charter of the company expires in 1968. The dividend for 1882 is expected to reach 16 per cent.

Little comment is required on these figures, and there can be little doubt as to what nationality the future management of the Canal should be entrusted, when four-fifths of the revenue is contributed by British trade. One cannot be surprised that there should arise a cry from British shipowners, that the time has arrived when the tax of ten francs per ton should be lowered. Abstractedly, it is a heavy burden, but relatively, it is less so, when it is remembered what economy in the expenses of transport has been effected by the saving in distance, and, therefore, in time, as well as in diminished risks and insurances. It is true that freights have fallen somewhat in proportion, and it may be said that, one year with another, the profits of the carriers are by no means so great as formerly; and it may be fairly urged, therefore, that the whole community is interested by the cost of transport being kept at the lowest figure possible. A tax which represents so considerable a fraction of the whole freight, 16 per cent., I am informed, ought to be reduced, especially when it is no longer needed for the security of the capitalists from loss.

In approaching the consideration of the Suez Canal as a political problem, the difficulties which surround a satisfactory solution of it must at once be acknowledged. It has been seen, how, though originating in a commercial speculation, the scheme contained, from the very first, elements of a political character, which the British Government of the day could not possibly ignore; and how, as its operations progressed, sharply accentuated differences of international policy have been manifested, requiring the best efforts of diplomacy to arrange. Though, happily for England, no rupture in friendly relations has occurred, yet recent events have only too plainly shown "how great a matter a little fire kindleth," and how small a circumstance might vitally affect the interests of England, as regards her Eastern possessions, by the closure of this great thoroughfare to India. The immense importance to this country of those clauses in the concessions in which the Government declares the company to be Egyptian, subjects it to all the laws and usages of the Turkish Empire, and reserves to itself entire control in all particulars, military and civil, have been unmistakeably manifest. Still more so, in the action of the Porte in insisting on the restoration of large tracts of land along the Canal's course, which had been at first made over, without due consideration, to the company; for had that land still remained in their hands, it is extremely doubtful whether national susceptibilities might not have interfered with the able and successful strategic movement of our troops from Alexandria to Ismailia.

Again, the overwhelming preponderance of British trade over that of all other nationalities, added to the fact that its magnitude alone enables the Canal Company to exist, and the Canal itself to be maintained, renders it imperative that that trade should not be imperilled, or its safety left dependent entirely on such strategic movements, the success of which a small error in judgment or a trifling miscalculation of time might wholly frustrate. It was pointed out, in a recent able article in the *Nineteenth Century*, that of all the naval powers England was furthest off from the Suez Canal, and in the event of hostilities, her enemies might be first on the scene, and occupy it some days before her fleet could possibly arrive; but, on the other hand, to be forewarned is to be forearmed, and England possesses harbours nearer the Canal than Portsmouth, and cruising ground nearer than the British Channel. If advantage be duly taken of these, and England is true to herself, the rest may be left safely to the judgment of Lord Alcester (late Sir Beauchamp Seymour), and such men as he has the good fortune to command.

But though such eventualities cannot be altogether ignored, yet there are, perhaps, other means left for procuring a more desirable solution of the desired end.

As far as can be judged from the sentiments expressed in the various organs of public opinion throughout Europe, there seems, with one exception, to be a tolerably unanimous desire that the management of the Suez Canal should be vested in British hands; just as there was at the time when Monsieur de Lesseps was anxious for the maritime powers jointly to purchase his scheme. The correspondence on that subject is published in Parliamentary paper Egypt, No. 2 (1876), and goes to show how nearly the Canal was changing hands. As

the practicability of that transaction was once seriously discussed, there is really nothing quixotic in a similar suggestion at the present time. To acquire the remaining shares, even at their enhanced value, would not be a financial operation beyond the power of England, which has, within the last few years, paid a much larger sum in wars than would probably be required to satisfy the demands of even the public spirited and patriotic shareholders of the Suez Canal. England could well afford to take over the whole of the obligations and liabilities connected with it, as, with the prospect of an increase of traffic such as is now opening up, the surplus of the receipts over and above the necessary current expenses would quickly furnish the means of discharging those obligations and liabilities, while the mercantile community and public generally would not grudge a continuance of even the present high due of 8s. per ton, so long as there was the certain prospect before it of its diminution to the small figure requisite to defray the necessary expenses of the up-keep of the Canal. For obvious reasons, details of calculations and figures cannot be entered into at the present time. If, however, international exigencies or individual susceptibilities should bar the way to such an amicable solution, and one profitable alike to all concerned, there remains a suggestion, which has elsewhere been made, of enabling the Ruler of Egypt to become the proprietor of a grand public work, which should never have been allowed to become the property of any private body of shareholders, but ought decidedly to have been undertaken solely and simply by the State. It is true that it is easy to be wise after the event, but it would equally be folly not to avail oneself of the wisdom when gained; and if, as was wittily remarked by the writer of the article in the *Nineteenth Century*, already adverted to, we are not only in the position of the *beati*, but the *beatissimi possidentes*, it will be odd if, with nine points of the law in our favour, we are not able to justify our proceedings. But even should this position be rendered untenable by a *force majeure*, there is yet a third resource, and that is, the construction of an alternative line of canal. This will, of course, be opposed on the ground that the several concessions conferred exclusive power on Monsieur de Lesseps for the construction of a canal across the Isthmus of Suez, east of the Damietta mouth. The exclusive power actually conferred, however, was that of forming a company for the purpose. If it excludes any other private individual from forming a company, it most assuredly did not exclude the Egyptian Government itself from making another canal anywhere it pleased within its dominions; and, therefore, the Egyptian Government is at perfect liberty to take whatever action it pleases in such a matter. But is it possible to make another maritime canal? Decidedly so; either east or west of the Damietta mouth. On the east, as far as can be judged from the line of coast surveys, a favourable approach and entrance could be formed in or about longitude 32°55, where the 5-fathom line runs nearest the coast, and from whence a pier, carried at an acute angle to the coast line on to the adjacent shoal, would form a protection against the littoral currents, while the Bay of Pelusium would afford an enormous area for receiving so much of the Nile deposit as would be arrested by the pier. As, however, the pier would run not perpendicularly, but at an acute angle to the coast, its interceptive action would be much smaller than that caused by the Western pier at Port Said. The line of the canal could be taken through Lake Sirbon, and then through more or less cutting to the Bitter Lakes; from whence a course could be found more or less parallel to the present Canal. The difficulty with regard to the supply of fresh water, which immediately suggests itself, could be overcome by pipes led from the Ismailia canal, under the maritime canal, into a reservoir, and pumped up from thence to every part of the new line. The probable cost of such a canal it is impossible to conjecture, in the absence of detailed surveys, but the difference between it and the existing line, if any, would be confined to the northern half. The economy which would be effected in the excavations by the experience already gained, would probably fully compensate for the increased depth of cutting, which might be unavoidable. A line to the westward could be found skirting the coast through the lagoon, and crossing the tidal rivers near their mouths as is now being done between Calcutta and Orissa.

A scheme for a fresh-water canal from Alexandria to Suez, *viâ* Cairo, attributed to the late Khedive, has lately been put forward, and advocated on the merits of its combining irrigating capabilities with those of navigation; but, independent of its practicability, or otherwise either technically or financially, it is simply out of the question that England could hazard its present trade of $4\frac{3}{4}$ million tons, much less its future trade of possibly five times that amount,

on a canal which would be exposed to such contingencies as are likely to occur to any fresh-water canal, whose navigability depends upon a series of locks, a class of works continually liable to derangement and injury.

An inter-oceanic canal ought, if possible, to be unencumbered throughout its entire length. Accidents, such as the wreck of a vessel, or the creation of shoals may occur, of course, at any time; but a few days would, at the most, suffice to clear a passage through them; whereas, the subsidence of a lock could not be remedied under many months; and if the existing maritime canal be in unfriendly hands, as it assuredly will be were a rival line constructed, then what will become of England's trade?

There is no more zealous advocate of canals combining the two properties of irrigation and navigation than the writer of this paper; but works suitable for the requirements of inland navigation come under a wholly different category to those adapted for the oceanic traffic. The late enlightened and shrewd ruler of Egypt would not have failed to appreciate the difference had it been clearly explained to him, and would have quickly seen that the interests of Egypt would not be advanced by such a work; while one of the chief ends desired, viz., to supply irrigation to the Delta direct and by gravitation, can be attained at one-fifth of even the estimated outlay of a ship canal, and all the requirements of internal navigation be simultaneously secured. In properly devised schemes of delta works, such as those in India, several alternative navigable lines are led to the chief port, so that, in the event of one being blocked, others are still available; but deliberately to leave the traffic of distant countries dependent on a single line of canal, the masonry works of which a few charges of gunpowder in time of war, or an unforeseen accident in time of peace might destroy, would, to say the least, be the gravest of mistakes—tantamount to an act of commercial, if not national, suicide.

In the event, however, of a satisfactory arrangement being come to as regards the existing Canal, there remains the question how it can be best adapted to meet the requirements of the traffic, which has already outgrown its capabilities. Opinions seem to be divided as to the alternative of enlarging the present course, and that of constructing a parallel line. At first sight, it would seem as if there could be no doubt as to the former being the most economical, both in regard to first outlay and subsequent working expenses. If there is not much of the excavated material in the banks to be removed, there can be no question as to the economy of widening the present Canal over excavating a new one, while the cost of supervision for working the traffic would remain the same; whereas, if there is a double line, there must be an increased establishment, though not necessarily a doubling of its numbers. On the other hand, there would doubtless be an advantage in having a double line, both in minimising the chance of accidents, and in expediting the transit through the canal, by almost entirely obviating the necessity for stopping in sidings; though, as a low speed would still have to be maintained, ships would not be able to accomplish the voyage in twelve hours, and would therefore be obliged to spend, at least, one night in the canal, as at present. An additional advantage of a double canal would be, that in case of either becoming temporarily blocked, the whole traffic would not be suspended; a point of very great importance when the number of vessels increases so rapidly, as it seems likely to do. It is concluded the expense of separate entrances at either end are not contemplated, but the present arrangements would be common to both lines. These, of course, could only exist, if the control is in the hands of England, or otherwise arranged for beyond the possibilities of risk in the time of war.

On the whole, however, after weighing the matter from all points of view, my own recommendation would be to enlarge the existing Canal to a width of 200 feet at bottom, the dimensions of the great canal from the River Sutlej, recently opened in North India, with such slopes to the sides as the nature of the soil admits of at different points of its course, and substantially revetted with stone where necessary. The speed of vessels might then be increased to a maximum of eight miles per hour, but limited to four miles when passing one another in opposite directions. As few steam vessels have a lower speed than eight miles, there would be no necessity, except in a few instances, of their overtaking each other; especially if an interval between the starting of each vessel at daylight is made compulsory. A restriction of traffic during the night may still be necessary, unless very perfect arrangements can be made for avoiding collisions; but it would be safest to confine the voyage to daylight hours, and to make it feasible to pass through the Canal between dawn and dusk.

There is yet one other phase in the political

aspect for consideration, and that is, what are the principal dangers to which, in time of war, the Suez Canal would be exposed? They are—

1. A blockade at either end.

2. The removal of buoys, beacons, and necessary adjuncts to the navigation.

3. Blocking up the Canal with obstacles of any kind.

4. The destruction or scuttling of vessels.

5. Last, but not least, cutting off the supply of fresh water from the Ismailia Canal.

The remedy for the first lies, of course, in the hands of the nation that commands the seas; and, if it is only careful to keep that command, it can equally anticipate and prevent any of the other dangers besetting the course of the canal itself. Cutting off the fresh-water supply could only occur in the event of another such eruption in Egypt as has lately been extinguished; and it would, no doubt, be done again, and done more effectually than it was on the last occasion. It rests entirely with England whether such an eruption shall be again possible; and whether, with the forewarnings she has received, and the experience which India has afforded her of a somewhat similar, though far graver, character, she shall not accept the position now thrust upon her, and herself keep the key of the Water Avenue that leads to her Eastern Empire.

It would be presumption on the part of the writer of this paper to offer further detailed suggestions on a matter which is entrusted to one of the ablest of diplomatists at England's command; but he cannot conclude without expressing his hope that the rumours of possible arrangements, as recently put forth in the daily journals, may prove to be inaccurate, and that it will soon become patent to the world that Egypt's extremity having made England's opportunity, the Suez Canal will no longer be allowed to remain an apple of international discord, and that it will prove to be the particular link in a chain of providential circumstances leading to the land of the Pharoahs once more recovering prosperity, with the help of England's guidance, and maintaining it under the ægis of England's power.

APPENDIX.

TABLE I.—VALUE OF IMPORTS INTO INDIA FROM ALL PORTS, INCLUDING TREASURE, IN THE UNDERMENTIONED YEARS.

	1875-76.	1876-77.	1877-78.	1878-79.	1879-80.	1880-81.
	£	£	£	£	£	£
Total merchandise from all parts, and by all routes	37,112,667	35,367,177	39,326,003	35,556,195	39,472,166	50,308,834
Proportion by Suez Canal	26,824,563	26,137,971	29,067,005	24,983,631	29,924,370	40,266,706
,, ,, other routes	10,288,104	9,229,206	10,258,998	11,582,564	9,817,796	10,042,128
Per-centage by Suez Canal	72·25	73·90	73·90	68·33	75·29	80·04
,, ,, other routes	27·75	26·10	26·10	31·67	24·71	19·96
Total treasure or bullion from all parts, and by all routes	5,300,722	11,436,118	17,355,460	7,056,749	11,655,395	8,997,214
Proportion by Suez Canal	2,449,325	7,007,109	13,157,327	3,106,807	5,582,870	5,279,804
,, ,, other routes	2,851,397	2,429,009	4,198,133	3,949,942	6,072,525	3,717,410
Per-centage by Suez Canal	46·20	78·76	75·81	44·02	47·90	58·68
,, ,, other routes	53·80	21·24	24·19	55·98	52·10	41·32
Total merchandise and bullion from all parts, and by all routes	42,413,389	46,803,295	56,681,463	43,622,944	51,397,561	59,306,048
Proportion by Suez Canal	29,273,888	35,145,080	42,224,332	28,090,438	35,507,240	45,546,510
,, ,, other routes	13,139,501	11,658,215	14,457,131	15,532,506	15,890,321	13,759,538
Per-centage total import trade by Suez Canal	69.02	75·09	74·50	64·39	69·09	76·80
Per-centage total import trade by other routes	30·98	24·91	25·50	35·61	30·91	23·20

TABLE II.—VALUE OF EXPORTS FROM INDIA, INCLUDING TREASURE, TO ALL PARTS IN THE UNDERMENTIONED YEARS.

	1875-76.	1876-77.	1877-78.	1878-79.	1879-80.	1880-81.
	£	£	£	£	£	£
Total merchandise to all parts and by all routes	58,045,405	60,961,632	65,185,713	60,893,611	67,173,158	74,531,282
Proportion by Suez Canal	21,813,007	22,661,178	23,365,011	21,920,404	25,897,990	33,223,284
,, ,, other routes	36,232,398	38,300,454	41,820,702	38,973,207	41,275,168	41,307,998
Per-centage by Suez Canal	37·57	37·17	35·84	36·00	38·55	44·58
,, ,, other routes	62·43	62·83	64·16	64·00	61·45	55·42
Total treasure or bullion to all parts and by all routes	2,115,144	3,942,580	2,155,136	3,895,545	1,928,828	1,409,404
Proportion by Suez Canal	375,101	1,428,634	1,263,729	2,527,492	441,653	176,520
,, ,, other routes	1,740,044	2,513,946	891,407	1,368,053	1,487,175	1,232,884
Per-centage by Suez Canal	17·73	36·23	58·63	64·88	22·90	12·58
,, ,, other routes	82·27	63·77	41·37	35·12	77·10	87·49
Total trade—merchandise and bullion to all parts and by all routes	60,160,549	64,904,212	67,340,849	64,789,156	69,101,986	75,940,686
Proportion by Suez Canal	22,188,108	24,089,812	24,628,740	24,447,896	26,339,643	33,399,804
,, ,, other routes	37,792,442	40,814,400	42,712,109	40,341,260	42,672,343	42,540,882
Per-centage by Suez Canal	36·88	37·12	36·57	37·73	38·12	43·99
,, ,, other routes	63·12	62·88	63·43	62·27	61·88	56·01

TABLE III.—AGGREGATE TRADE OF INDIA FOR EACH OF THE UNDERMENTIONED YEARS.

	1875-76.	1876-76.	1877-78.	1878-79.	1879-80.	1880-81.
	£	£	£	£	£	£
Total merchandise exported and imported from and to all parts and by all routes	95,158,072	96,328,809	104,511,716	97,459,806	106,915,324	124,840,116
Proportion of merchandise by Suez Canal	48,637,570	48,799,149	52,432,016	46,904,035	55,822,360	73,489,990
Proportion of merchandise by other routes	46,520,502	47,529,660	52,079,700	50,555,771	51,092,964	51,350,126
Per-centage by Suez Canal	51·11	50·66	50·17	48·12	52·21	58·87
Per-centage by other routes	48·89	49·34	49·83	51·88	47·79	41·13
Total treasure bullion	7,415,866	15,378,698	19,510,596	10,952,294	13,584,223	10,406,618
Proportion by Suez Canal	2,824,426	10,435,743	14,421,056	5,634,299	6,024,523	5,456,324
,, other routes	4,591,441	4,942,955	5,089,540	5,317,995	7,559,700	4,950,294
Per-centage by Suez Canal	38·09	67·85	73·91	51·44	44·35	52·43
Per-centage by other routes	61·91	32·15	26·09	48·56	55·95	47·57
Aggregate trade, merchandise and treasure	102,573,938	111,707,507	124,022,312	108,412,100	120,499,547	135,246,734
Proportion by Suez Canal	51,461,996	59,234,892	66,853,072	52,538,334	61,846,883	78,946,314
,, other routes	51,111,942	52,572,615	57,169,240	53,873,766	58,652,664	56,300,420
Per-centage by Suez Canal	50·17	53·02	53·90	48·46	51·33	58·37
Per-centage by other routes	49·83	46·98	46·10	51·54	48·67	41·63

TABLE IV.—TOTAL IMPORTS OF MERCHANDISE INTO BRITISH INDIA FROM BRITISH POSSESSIONS AND FOREIGN COUNTRIES, IN EACH OF THE UNDERMENTIONED YEARS.

Countries.	1876-77.	1877-78.	1878-79.	1879-80.	1880-81.
	£	£	£	£	£
BRITISH POSSESSIONS :—					
United Kingdom	29,752,448	32,211,303	28,912,136	32,042,848	41,292,635
Mauritius	253,377	642,471	1,303,321	843,040	1,206,190
Straits Settlements	937,342	1,079,702	1,165,875	1,278,645	1,476,244
China—Hong Kong	1,062,418	1,221,537	1,267,671	1,340,900	1,557,170
Other Possessions	963,311	1,008,567	813,677	826,243	715,819
Total	32,968,896	36,163,580	33,462,680	36,331,676	46,248,058
FOREIGN COUNTRIES :—					
France	463,504	451,105	391,034	428,279	705,580
Italy	334,009	349,229	383,014	449,606	576,327
America, United States	172,376	279,717	348,823	526,262	490,848
Persia	365,526	469,507	566,736	537,210	490,057
China (Treaty Ports)	47,441	202,136	126,703	238,175	432,592
Other Countries	1,015,441	1,410,729	1,287,205	1,230,958	1,365,372
Total	2,398,281	3,162,423	3,103,515	3,410,490	4,060,776
Total from British Possessions and Foreign Countries	35,367,177	39,326,003	36,566,195	39,742,166	50,308,834

TABLE V.—VALUE OF TOTAL EXPORTS OF INDIAN PRODUCE AND MANUFACTURES TO EACH BRITISH POSSESSION AND FOREIGN COUNTRY IN THE UNDERMENTIONED YEARS.

Countries.	1876-77.	1877-78.	1878-79.	1879-80.	1880-81.
	£	£	£	£	£
BRITISH POSSESSIONS :—					
United Kingdom	28,020,106	29,613,606	25,903,848	27,394,925	31,007,561
Mauritius	945,860	1,148,217	1,175,716	994,660	756,814
Straits Settlements	2,375,677	2,581,736	2,732,276	2,723,298	3,161,747
Ceylon	2,312,342	2,544,516	2,949,071	2,002,032	1,778,531
China—Hong Kong	11,185,739	10,276,365	10,260,193	10,261,508	10,806,573
Other Countries	839,244	437,449	1,114,400	1,187,144	1,776,880
Total	45,678,948	47,101,892	44,135,504	44,563,567	49,288,056
FOREIGN COUNTRIES :—					
Austria	1,427,983	1,465,891	1,394,911	1,859,015	2,226,011
France	5,358,053	5,967,002	3,941,572	4,853,884	6,496,012
Italy	1,410,065	1,870,006	1,673,195	2,214,839	2,781,204
America, United States	1,895,610	1,932,728	2,038,690	3,286,650	2,618,225
Egypt	452,800	577,800	346,036	971,785	1,423,395
Persia	768,567	873,193	1,034,750	1,032,154	1,043,651
China (Treaty Ports)	1,502,308	2,466,781	3,413,097	5,262,170	4,137,077
Other Countries	2,467,298	2,930,708	2,915,856	3,129,094	4,517,651
Total	15,282,684	18,083,821	16,758,107	22,609,591	25,243,226
Total to British Possessions and Foreign Countries	60,961,632	65,185,713	60,893,611	67,173,158	74,531,282

TABLE VI.—TOTAL QUANTITIES AND VALUES OF THE FOLLOWING ARTICLES OF INDIAN PRODUCE AND MANUFACTURE EXPORTED FROM BRITISH INDIA, IN THE UNDERMENTIONED YEARS.

Articles.	1876-77.		1877-78.		1878-79.		1879-80.		1880-81.	
	cwt.	£	cwts.	£	cwts.	£	cwts.	£	cwts.	£
Coffee	302,489	1,345,822	297,862	1,338,499	341,186	1,543,643	359,000	1,626,747	369,357	1,599,669
	lbs.		lbs.		lbs.		lbs.		lbs.	
Cotton, raw	510,486,368	11,746,184	387,416,624	9,383,534	332,191,720	7,913,046	412,229,312	11,145,453	508,652,368	13,241,734
,, twist	7,926,710	367,303	15,600,291	682,059	21,332,508	886,481	25,862,474	1,109,234	26,901,346	1,282,576
	cwts.		cwts.		cwts.		cwts.		cwts.	
Rice.....	19,548,741	5,742,540	18,211,388	6,889,362	20,621,712	8,810,121	21,908,045	8,341,685	26,769,344	8,971,661
Wheat.....	5,583,336	1,956,333	6,340,150	2,856,990	1,044,709	513,779	2,195,550	1,121,015	7,444,375	3,277,942
	Nos.		Nos.		Nos.		Nos.		Nos.	
Hides and Skins ...	654,115	2,998,684	905,835	3,756,887	809,233	3,096,847	958,679	3,738,004	811,989	3,733,565
	cwts.		cwts.		cwts.		cwts.		cwts.	
Jute, raw..	4,533,255	2,636,647	5,450,276	3,518,114	6,021,382	3,800,426	6,680,670	4,370,032	5,809,815	3,934,030
Saltpetre...	466,218	381,706	389,022	379,002	382,405	361,766	509,372	469,797	352,995	351,728
Seeds	9,582,865	5,319,124	12,187,020	7,360,284	7,200,977	4,675,036	7,091,469	4,685,893	10,229,109	6,345,209
	lbs.		lbs.		lbs.		lbs.		lbs.	
Tea	27,784,124	2,607,425	33,459,075	3,044,571	34,432,573	3,138,423	38,173,521	3,051,020	46,413,510	3,054,240

DISCUSSION.

The CHAIRMAN said he had received a note from Sir Andrew Clarke, expressing his regret that he could not be present, and as he and Captain (now Admiral) Richards, reported on the Canal in 1870, when the Canal was somewhat under a cloud, he might take this opportunity of saying that Sir Andrew Clarke then took a much more hopeful view of it than many, and his views had turned out to be accurate. It had been stated, from time to time, in French and other journals, that all English engineers were opposed to the construction of the Canal; but he held in his hand his own report, made on the 3rd February, 1863, two clauses from the conclusion of which would put an end to such reports, at any rate as regards himself. He there said:—"Having now reviewed several matters connected with the engineering construction, and with the maintenance of the Canal, I have arrived at the following conclusions:—Firstly, as regards the engineering construction, there are no works on the Canal presenting on their face any unusual difficulty of execution, and there are no contingencies that I can conceive likely to arise that would introduce difficulties insurmountable by engineering skill. Secondly, as regards the maintenance of the Canal, I am of opinion that no obstacles will be met with that would prevent the works, when completed, being maintained in their efficiency without the necessity of incurring an extraordinary or unusual yearly expenditure." The paper now read raised many important points, and would lead to a very long discussion if it were to be treated in detail. The idea of constructing a second canal was by no means new, for he was requested, during the reign of the late Khedive, to go to Egypt, and lay out the line of a second canal which should be available for irrigation. He declined to do so, however, as he thought such a scheme was then premature. As the question had been again raised, he would say that he quite agreed in the opinion expressed in the paper, that such a thing was undesirable. If it were to be used for irrigation, it must be a fresh-water canal, and would be subject to draughts upon it from lateral canals. He could not advise commercial men to send their ships into a canal having so many outlets, and liable to the chances of accident arising in consequence. He was still of opinion that the idea of a second canal was premature at present; the Suez Canal Company had lately determined to expend very large sums in improvements, and it would be premature to begin a new one until they had shown what they intended to do. He did not see that any political difficulties which might arise with our own and other Governments from the existence of one canal, would be at all diminished by having another. Arrangements would be practicable with the present company, but if another canal were made, arrangements would have to be made with it also. If it were to be made by the Egyptian Government, the question arose—What was the Egyptian Government? He thought it would be hard to say if we should be any better off with another canal made by the Egyptian Government than we were with a French company.

Mr. MARTIN WOOD said a point had been made in a paper written by Mr. Rathbone, M.P., that a smaller proportion of Indian exports was now brought to England than before the construction of the Canal, because a great portion went to the Mediterranean ports. Of course that said nothing against the value of the Canal as a whole, but was an incidental point to be borne in mind. Seeing the large percentage paid by the present Canal, there was evidently a margin for an additional line; but it would be presumptuous on his part to say anything on the question of a fresh-water canal through the centre of Egypt, which had been so thoroughly discussed in the paper. Still, he hoped some engineer

who had examined the question would be able to say a little more in its behalf. Engineering science, especially with regard to the construction of locks and other canal works, had much advanced of late years, and a degree of security could now be obtained which was unknown in former times. With regard to the political aspect of the question, no doubt General Rundall's observations would meet with general approbation. This Canal being an inter-oceanic highway, was a matter of interest to all nations; it was not necessarily a question of tonnage, or of weight of metal, but each had an interest in proportion to its trade, and that was an additional reason why the control and protection of the Canal should rest with England. The foundation of the question was that the Canal run through Egyptian territory, and, therefore, Egypt itself was primarily concerned, and had the first right in the matter.

Mr. J. T. Wood remarked that in approaching the question of the reduction of rates, the prosperity of Egypt in the future rather than at present must be considered. The question was, how far Egypt might be expected to take the place now occupied by this country, as a centre of distribution of the commerce between the East and West—a centre where the trans-shipment of that commerce might economically take place. The grand success of the Suez Canal was really due to the saving of time and injury to goods in trans-shipment. When dealing with such a quantity as even a million of tons, railways would carry that traffic from Suez to Alexandria at a considerably cheaper rate than the Canal, including the cost of taking it out of the vessel on one side and reloading it on the other. But that would involve the delay of many days, and made the journey round the Cape on the whole more economical. It struck him that the first thing to be done was to enlarge the Canal, so as to give greater facilities for through transport, but they must also look forward to the time when large warehouses and even towns would rise on the banks of the Canal, where trans-shipment would take place, and Egypt would again become the centre of commerce. He ventured to throw out this idea, in the hope that others would bestow some attention to it.

Mr. F. W. Fox said one point of considerable importance was the first cost of the Canal, which was £20,000,000. Upon that cost, at least 5 per cent. had to be reckoned; but if a new canal were made parallel to the first, it could be constructed for eight or ten millions, the interest upon which would not be more than half that required for the existing one, and then the existing rates might be reduced by one-half. But that was not at all; supposing the rates were reduced from 8s. to 4s. per ton, and the Canal were open at all hours, what would be the effect on our Indian empire? It would totally revolutionise it. At present our wheat supplies were mainly drawn from America, but, with lower rates, we should bring much more wheat from India. It was, therefore, the duty of England, as a nation, either to free the existing Canal from difficulties, or to go forward and construct a new one. As regards the fresh-water canal, it was obvious to all acquainted with the subject, that as the locks ascended 80 ft. to 90 ft., for which distance all vessels, even of 4,000 to 5,000 tons, would have to be lifted, it would take from 36 to 48 hours for ships to pass through the canal, which would be a fatal objection.

Mr. B. Francis Cobb said the cost of the Canal was considerably under-estimated. No notice had been taken of the forced labour which was employed by the Khedive, who used up some thousands of his subjects, for which no charge was made; and if such labour had to be paid for, it would form a very considerable item. Some of the statistics as to the trade through the Canal were misleading, as regarded the countries to which the trade belonged. Had one taken the Blue-book a few years ago, and seen the quantity of silk exported from Egypt, it would have appeared very considerable, because all the bales of silk from India and China were landed on one side of Egypt, passed through by caravan, and, as far as our Custom-house records showed, imported from Egypt, though really they came from the far East. So, in these statistics, no notice was taken of the large trade done by Germany with India direct, which showed in the exports from Italy and France, but did not represent Italian and French goods. The whole German exports of manufactured goods, and the import of Indian produce, such as indigo, would be carried by the steamers going to Marseilles Venice, and Trieste. Those who, like himself, had been stopped thirty-six hours at one place in the Canal, where there were fifteen other steamers lying at the same time, while a ship was being put straight, could very well understand the great desire there was amongst steamer captains for another canal, even if it were side by side with the present one. Scarcely a week passed in which there was not a telegram posted up at Lloyd's, "Canal blocked," to be followed by, "Canal free again;" and it sometimes occurred several times in one week. In the present condition of the Canal, it was impossible to prevent this occurring from time to time. The Canal was so narrow that the water did not act, as explained in the paper, sufficiently rapidly on the ship's rudder, and so she lost steerage way, and ran into one bank or the other; and, finally, got across the Canal, and had to be lightened—a work of twenty-four or thirty-six hours. The Canal Company did all that could be done on such occasions, and he had admired the facility with which they had brought down tugs and craft for lightening the ship, and when she was put straight, and taken into a gare, reloaded, whilst the traffic passed on. All these appliances were admirable, but the time would be sure to come, sooner or later, when a more serious accident would occur, and some large steamer would sink in the deeper water. Such an accident nearly occurred

within the last three months, when a steamer, while getting off the bank, settled on her anchor, made a hole in her bottom, and one of her compartments filled. If such a thing occurred at the water-tight bulkhead, and two compartments filled, she would probably sink to the bottom of the Canal, and block it for some weeks, at all events. The mere widening of the Canal in places, as at present proposed, would hardly meet the difficulty. It ought to be widened sufficiently for steamers to pass at any part of it; or a second canal made parallel with it, unless for some political reasons it were thought desirable to have it in another position. He believed the best place for the mouth of a canal would be even further east than General Rundall had mentioned, at the point where the entrance would lie rather in a north-easterly direction. The theory was that the whole of the sediment from the Damietta mouth would deposit in the first bay, as it had been doing for the last ten years, while, at the point he had indicated, the deep water-line ran in pretty close. The present mouth was getting more and more difficult to enter at night; the piers went further out, and pilots were more and more afraid of attempting to get in after sunset. The piers were kept parallel, and the entrance would be much easier if they could be made to diverge, but it was said that if this were done they would let in sediment which would block up the passage.

Mr. LIGGINS said a great deal of cold water was thrown on the Suez Canal scheme in its origin by one of the ablest Prime Ministers England had ever had, the late Lord Palmerston, who was guided in this matter by Mr. Stephenson, but he believed a great deal of pressure was brought to bear on both those eminent men by the commercial community of England, who considered the Canal would be detrimental to their interests, and consequently to the country at large. Notwithstanding the figures which had been quoted—which he could show were fallacious—he considered that one of the most unfortunate things which ever happened for England, was the construction of the Suez Canal. Before it was opened England had the monopoly of the carrying trade of the Eastern world round the Cape of Good Hope, and the freights obtained were very large—£6 a ton, not 48s., of which they heard now; and that £6 a ton went to enrich the country. As soon as the Canal was opened, the whole of the Mediterranean ports were two or three weeks in advance of us; they were nearer Australia, New Zealand, Japan, and India; and the Indian people would take their goods from the ships that first arrived. If the strict accuracy of these figures could be relied upon, they must believe that the Messageries Maritimes steamers from Marseilles, the Austrian Lloyd's from Trieste, all went out empty. They were as fine ships as our P. and O. steamers, Clyde built; and he knew a high official of the Indian Government who was now on his way home in one of these French ships in preference. Every foreign vessel which came through the Canal brought goods which would otherwise have come in English ships, and, therefore, he did not admit, now, that it was any advantage to England. It could not be altered now, and he would not shut up the Canal if he could; and, in his opinion, no wiser policy was ever adopted than when Lord Beaconsfield bought the Suez Canal shares for four millions, for they were now worth eight. But it was useless to talk of England buying the French shares, and so getting the control; the prosperity of the company was so great that the French holders, who were not the Government but private individuals, would not sell them.

Sir JOHN COODE said he felt called upon to enter a protest against any such idea as seemed to be entertained by Mr. Liggins, that a highminded and honourable man like the late Robert Stephenson would be at all guided in the opinion he gave on any engineering question by such pressure as had been referred to.

The CHAIRMAN having proposed a vote of thanks to General Rundall, which was carried unanimously,

Lieut.-General RUNDALL, in reply, said he was quite aware, as had been mentioned by the Chairman, that all English engineers had not been adverse to the Canal, though some were; and with respect to the Chairman himself, he knew that he supported it, because he read his report upon it some twenty years ago. Mr. Liggins had referred to the losses which shipowners had sustained by the opening of the Canal in the diminution of freights. Not being a shipowner, and not being intimate with these matters, he could not say much about it; but at the same time, when sailing ships went round the Cape, it took 12 months for the out and home voyage, and all that time the merchants were losing interest on their money, and the expenses of the ship must have been very considerable, being spread over twelve months, instead of three. Besides, why in the world should shipowners go on building ships if it were such a losing business? The same gentleman also called in question the accuracy of these figures. He was not responsible for them; they were the returns of the Canal authorities, and if they did not know the different nationalities of the ships, who was to know? If the figures could be proved to be erroneous, the sooner the proof was given the better. But there could be no question of the preponderance of British trade. A remark was made that the exports from India to England had fallen off, and on that point he could only say, that though he had endeavoured to do so, he had not been able to get accurate returns from the different Mediterranean ports, which would, no doubt, throw some light on the matter. But nearly 45 per cent. of the trade of India came to this country, and the greater portion of the remainder went to countries eastward of India, opium forming a very large item in the value.

Miscellaneous.

ON SILK-PRODUCING BOMBYCES REARED IN 1882.

By Alfred Wailly
(Membre-Lauréat de la Société d'Acclimatation de France).

(Continued from p. 192.)

Cricula trifenestrata.—In 1882, for the first time, I obtained cocoons of this curious species; they were sent to me from Madras. These cocoons, like those of *Caligula Simla*, are a beautiful net-work, which allows the pupa to be seen; they are of a golden-yellow colour, while those of *Caligula Simla* are of very dark colour, almost black. Nothing could be done with this interesting species, the pupæ having died for the most part. Only a few moths emerged, as follows:—July 4th, one female; on the 9th, one female; on the 13th, one female; on the 15th, one female; and on the 26th of July, one male.

Hybrid Roylei-Pernyi.—This, my new oak silkworm, is, in my opinion, the most important of the oak silkworms reared up to the present time. It was obtained by me in the latter part of May and beginning of June, 1881, by the crossing of six female *Roylei* with six male *Pernyi*; and an article on this large oak silkworm is inserted in my report on the rearings of 1881, which report appeared in the *Journal of the Society of Arts* on the 10th and the 31st of March, and April 7th, 1882. By referring to my article, it will be seen that what I anticipated then took place, that is, that the hybrid would be susceptible of being reproduced in 1882 from the cocoons obtained in 1881, on account of the close relationship of the parent species.

The success I obtained in the reproduction of the hybrid from the cocoons obtained last year went far beyond my most sanguine expectations. With a comparatively small number of cocoons, twenty-seven or twenty-eight, I obtained a considerable number of fertile ova. The moths never failed to pair, the males even pairing three times. When I had no female hybrid moths, the males paired with other species.

The larvæ obtained this year, like those of last year, were of the hardiest and easiest to rear. In spite of the cold uninterrupted and heavy rains of last June and part of July, the larvæ, half-drowned during the rains, throve remarkably well in London on small oak trees bearing but a small quantity of sickly, yellow-spotted foliage, and they reached an enormous size before spinning their cocoons. Here in London, working under the greatest difficulties, I can only rear a very small number of each species; had it been in the country, I could have obtained a large number of cocoons.

In July, the Editor of the *Journal of the Society of Arts*, did me the pleasure to come here, and he saw the larvæ of my hybrid, with those of *Selene*, *Roylei*, *Polyphemus*, and other species, when they had for the most part reached their full size and beauty. Mr. F. Moore, curator of the Bethnal-green Museum, also came here about the same time, and had specimens of the larvæ moths and cocoons for the Museum. It was most gratifying to me to have the visit of these gentlemen, because few persons can form an idea of what can be done with the rearing of these large wild silkworms in the open air, even under most adverse circumstances.

The Editor, after his visit, wrote a short notice on the silkworms he saw on the little trees in my garden; this notice appeared on the 8th of September, in the *Journal of the Society of Arts*. Another notice referring to my hybrid had appeared previously, on the 30th of June. This was after I had submitted to the Council of the Society of Arts, for their inspection, specimen cocoons and moths of my hybrid with some of the parent species, *Roylei* and *Pernyi*.

With the specimen cocoons and moths, I sent to the Society of Arts the following note, dated 20th June, 1882:—"Gentlemen, I have the honour to submit to your notice, specimen cocoons and moths of a new silkworm, created by me, last year, by the crossing of *Attacus (Antheræa) Roylei* female, the Himalaya oak silkworm, with *Attacus (Antheræa) Pernyi*, the North China oak silkworm. By comparing the cocoons and moths of my hybrid, it will be seen that it is larger and superior to the parent species, *Roylei* and *Pernyi*. But this is not all, the larvæ of this hybrid were reared with the greatest success in France, Germany, Austria, England, Scotland, and the United States of North America, and everywhere splendid cocoons were obtained. This year (1882), in April and May, the moths emerged from the cocoons in nearly equal proportions of males and females, all perfect insects, which paired with the greatest facility, the male moths pairing even three times. I have obtained a very large quantity of fertile ova, some of which have been sent to Europe and America. Larvæ of the new hybrid have been placed on the little oak trees in my garden, and in spite of the very unfavourable weather we have had this month, they are in splendid condition; they are the hardiest larvæ I ever reared. Contrary to what has taken place with the crossing of different species of silk-producing Bombyces, I have this time produced a new species which is larger, stronger, and I think superior in every respect to the parent species, and susceptible of reproduction."

The first hybrid moth obtained was a female, which emerged during the night of the 22nd and 23rd of April, 1882. This specimen, with the cocoon, I took to Mr. W. F. Kirby, at the British Museum, in order that he should describe it, and submit it to the Entomological Society of England. Later on, I sent other specimens. At the meeting of the 3rd of May, 1882, H. T. Stainton, Esq., F.R.S., &c., president, in the chair, Mr. W. F. Kirby read the

following, which appeared in the "Proceedings" of the society :—

"Notes on a Hybrid between *Antheræa Pernyi*, Guér., and *A. Roylei*, Moore."

"M. Wailly, the well-known rearer of silkworm moths, has succeeded in obtaining hybrids between *Antheræa Pernyi* and *A. Roylei*, and has requested me to describe one of the moths. *A. Pernyi* is the well-known oak-feeding silkworm of North China, and *A. Roylei* is a North Indian species, also an oak-feeder. Hence they are not species occurring in the same locality in a state of nature. M. Wailly states, in a paper lately published in the *Journal of the Society of Arts*, that the male *Pernyi* paired readily with the female *Roylei*, and that the hybrid larvæ (which he describes) proved much more easy to rear than those of *A. Roylei*, with which he had but little success.

"The hybrid before me expands just six inches across the wings, which is about the size of large female examples of the two parent species. It is of a greenish-buff colour, nearly as in the female of *Roylei*, but much clearer, and with a distinct tawny shade, especially within the common band; the body and base of the wings are also suffused with a distinct vinous shade more resembling *Pernyi* than *Roylei*; the shape of the wings also agrees better with *A. Pernyi*. On the other hand, the eyes resemble those of *Roylei*, but are considerably larger, the pupil especially being as large as in *Pernyi*, but the projection of the black outer rim, so conspicuous in *Pernyi*, is scarcely indicated. The other markings of the wings are well-defined, and resemble those of *A. Roylei*. On the under surface, the insect agrees in colour and markings with typical *Roylei*, but the basal band is less distinct, and perhaps less waved, and the submarginal black spots, dusted with white and pink, are larger and more distinct. Just inside there is a very faint dark stripe, more distinct on the right wing. In *Roylei* this is still more indistinct, whereas in *Pernyi* it is well marked, but closer to the spots. The antennæ and body of the hybrid are more like *A. Pernyi* than *A. Roylei*. The cocoon is fully as large as that of *Roylei*, but instead of there being a considerable space between the outer and inner cocoon, there is scarcely any interval between them. *A. Pernyi* has a similar but much smaller cocoon, and hence it would appear that that of the hybrid would be of greater commercial value than either."

(To be continued).

WATER EXAMINATION.

At the close of the article, "Reports on the Examination of Thames Water" (*Journal*, December 15, p. 87), reference was made to the four methods of water analysis—"the ignition," "the combustion," "the ammonia," and "the oxygen," and also to the criticisms on the value of these processes by the inventors themselves, and by others.

A recent supplement to the United States National Board of Health Bulletin, gives a preliminary report of an investigation relating to water analysis, which has been conducted by Professor J. W. Mallet, of Virginia, at the instigation of the Board. One object was to ascertain the actual and the relative value of "the combustion," "the ammonia," and "the oxygen" processes. Three chemists were appointed, one for each process; and the various waters, which were to be used as a means of ascertaining what the processes could detect, were distributed by Professor Mallet. Some of these were natural waters, and others were artificially prepared, with known amounts of infusions of vegetable and of animal origin, and with morbid products of human disease. These were divided into eight classes, while as a still further test, there were prepared (Class IX.) solutions in distilled water of carefully determined amounts of pure substances of definite chemical compositions.

The defects and the excellencies of each of the processes, as tested in these ways, are stated, and have a high importance for specialists. For those who are interested rather in trustworthy results than in processes, the most valued section of the report is that on the chemical and biological results, as contrasted with the actual sanitary history of the natural waters examined. It is stated that no important differences are presented from the three methods for the estimation of the organic matters between Class I., generally wholesome waters, and Class II., waters medically condemned and fairly assumed as pernicious. No one could, with the tabulated results alone to guide him, refer a water of unknown origin to one or other of the two classes on the basis of chemical analysis by any or all of the three methods. In many of the most dangerous waters but a small amount of organic matter was indicated. As regards the results for nitrates, the differences between Classes I. and II. were more marked. These salts were but trifling in amount in Class I., while in Class II. they were always present, and often in larger quantity. Among the artificially polluted waters, which, by biological tests, were regarded as suspicious, there were many in which no nitrites nor nitrates were found, but there was, generally, a large amount of ammonia. The idea is suggested whether the noxious character of waters containing large quantities of nitrites and nitrates may not be really due to some special nitrifying ferment, to be classed among the lower organisms capable of propagating disease.

The biological observations were undertaken by Professor Martin and Dr. Hartwell, but the results are thought not to give a means of determining the distinction of a wholesome or unwholesome natural water. The method adopted was that of injecting the waters under the skin of animals, but the report points out the desirability of further experiments, and that the action of water introduced into the stomach should be tested. A further important suggestion is made, that there should be a

combined chemical and biological inquiry as to the possible effects on living animals of the ferment or ferments of nitrification in different stages of that process.

It has often been argued that water containing peaty matter, even when much, is harmless, yet it showed strongly marked pathological effects in the experiments. On the theory of disease caused by drinking-water being due to the action of living organisms, it might be safe to drink peaty water when fresh. But after some exposure, when bacteria might have become developed, there would be danger, though possibly after a still longer period, when the growth of these had fallen off, and the organic matter had been "used up," there might be safety. It is stated, that the water of the Dismal Swamp is found by ships' captains to become wholesome after a while—a statement of considerable significance when it is remembered that the experience with Thames water taken on board and stored, is that it becomes excellent drinking water after it has "fermented."

With regard to the amount of organic matter which makes a water dangerous, the following is mentioned as complicating the inquiry. In two of the waters subjected to examination, waters believed to be of a highly dangerous character, the amount of organic matter, as detected by analysis, was so small, that if the whole of the carbon and nitrogen present had existed as strychnine, it would be necessary to drink half a gallon of the water at once in order to take such an average dose as might be prescribed medicinally. The probability of the products of putrefactive change being so much more poisonous that the strongest of our recognised poisons, is spoken of as difficult of belief. Whether the quantity, within such ranges of variation as are likely to occur in a water used for drinking purposes, is a matter of any importance, affects the question of the utility of any process for determining the amount.

With regard to practical points bearing on the water analysis of town supplies, Professor Mallet urges that no one of the three processes should be alone depended on. He recommends the use of all three, as each gives information the others do not. Processes for the estimation of organic matter should be used only in connection with investigations of other more general evidence as to the source and history of a water. He believes there are no sound grounds for the establishment of such "standards of purity" as have been proposed. Several suggestions are given as to possible improvements in all these processes.

Correspondence.

SANITARY INSPECTION OF HOUSES.

Until my recent retirement from office, I was for many years in official relations, first with the Privy Council Department, and subsequently with the Local Government Board, in regard to sanitary matters; and I had purposed, as a member, taking part in the discussion on Mr. Burton's useful paper, but ill health, connected with the very subject in question, prevented me. I must, therefore, content myself with a few remarks and suggestions.

Mr. Mineard seems to look to the Board of Trade for a remedy of existing sanitary abuses; and it is true that passenger and emigrant ships, which are practically houses afloat, are well looked after by that department, which issues certificates periodically, such certificates being paid for by the ship-owners; but it seems to me that the Local Government Board, which has already a considerable staff, and ample powers, is the more suitable Board to deal with the subject. I agree with Messrs. Collins and Cresswell that local authorities have, under the bye-laws issued by the Local Government Board, considerable powers; but are they carried out? And if they were, what could be expected of the class of men at present employed as parochial inspectors of nuisances, good though they may be as such? It is simply a farce.

The proposals I venture to submit for consideration are:—First, that sanitary inspectors of houses should be appointed by local authorities, but not allowed to act until examined by the Local Government Board officials, and granted a certificate of competency. Secondly, that such inspectors should be of a higher class, and better paid than ordinary inspectors of nuisances; and that, in order to meet the increased expense without increasing the rates, the local authorities should be empowered to charge a certain fee, to be determined upon, for each certificate granted by their inspectors under existing or any improved bye-laws. Thirdly, that every builder or house-owner should be compelled to produce such a sanitary certificate to a tenant on demand.

Such, it appears to me, would be the simplest mode of utilising existing arrangements without increasing the rates, at the same time putting the saddle upon the right horse; and I can only hope that it will meet with consideration and, probably, with improvement, by those who have more power to act in the matter than myself.

JOHN WM. WOOD,
Late Chief Officer, Board of Trade and Customs, &c., Harwich.

34, Great St. Helens, E.C.,
January 20, 1883.

I see that the few remarks I made in the discussion on Mr. Burton's paper have not been correctly reported. I did not say that out of a thousand houses I had examined I only found three which were sound. Mr. Burton had stated that, probably, only one drain in a thousand was sound; and I remarked that, though I was not prepared to endorse this precise statement, there could be no doubt that the vast majority of house drains were leaky; in sup-

port of which I mentioned that, though I had been testing drains for the last eight or ten years, I had only found three sound ones. I further explained that even in laying new drains, with the greatest care, I found that, on applying the test, they were generally not made sound in the first instance, and, consequently (after the defects had been remedied), they had to be tested a second time, before the drain could be passed as sound.

ROGERS FIELD.

5, Cannon-row, Westminster, S.W.,
January 22nd, 1883.

Notes on Books.

CACAO: How to Grow and How to Cure it. By D. Morris, M.A., F.G.S. Jamaica, 1882. Sm. 8vo.

As the common word cocoa is incorrect in form, and liable to be confused with coco-nut, or coca, or cocos, the author adopts the specific name *cacao* throughout his little book. It is only within the last few years that cacao cultivation has been attended to in Jamacia. The following table shows how largely the amount exported increased in the years 1878, 1879, and 1880:—

Year.	Quantity Exported. cwt.	Value. £
1875	311	873
1876	459	1,286
1877	375	1,051
1878	1,694	7,832
1879	2,153	6,631
1880	3,304	10,918

The author believes that the foundations of an important industry are being laid, which, in a few years, cannot fail to have appreciable effect upon the prosperity of the country. It appears that about two centuries ago, cacao was largely cultivated in Jamacia, but that a blast (or hurricane) swept over the plantations and so injured them, that the cultivation was never resumed. The author gives a description of the cacao or chocolate tree, and then explains how to start a cacao plantation. In subsequent chapters, the modes of planting, pruning, sweating, and curing of cacao are all described.

SOCIAL WRECKAGE; A Review of the Laws of England as they Affect the Poor. By Francis Peek. London: Wm. Isbister (Limited). 1883. Sm. 8vo.

This book is partly founded on a previous work of the author's, entitled "Our Laws and Our Poor," but it is largely made up of new matter. The chief points to which Mr. Peek draws his readers' attention, are the influence of the Poor-laws, which he affirms is to foster pauperism and discourage providence, the licensing laws, the administration of justice, and the inequality of punishments.

RECOLLECTIONS OF DANTE GABRIEL ROSSETTI. By T. Hall Caine. London: Elliot Stock. 1882. Sm. 8vo.

Mr. Caine, who was of late years an intimate friend of the subject of this book, does not offer his recollections as a memoir of the painter-poet who died last Easter, but as a picture of the man which shall take the place of a biography until the appearance of a fuller work, which it is expected Mr. Theodore Watts will produce in due course. The book deals chiefly with the literary side of Rossetti's character, and contains little about his pictures, with the exception of an account of the formation of the Pre-Raphaelite brotherhood.

General Notes.

BRUSSELS PHOTOGRAPHIC EXHIBITION.—The Belgium Photographic Association propose to hold an exhibition in the galleries of the Palais de Beaux Arts, from August to October. Objects sent for exhibition must be received before the 15th of July, and intending exhibitors should communicate with the secretary, M. A. Géruset, Rue de l'Ecuyer 27 bis, Bruxelles, not later than 1st of June.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

JANUARY 31.—"Ensilage in the United States." By Prof. J. E. THOROLD ROGERS, M.P. Sir B. T. BRANDRETH GIBBS will preside.

FEBRUARY 7.—"The Modern Lathe." By J. H. EVANS. T. W. BOORD, M.P., will preside.

FEBRUARY 14.—"Some Points in the Practice of the American Patent Office." By SIR FREDERICK BRAMWELL, F.R.S. R. E. WEBSTER, Q.C., will preside.

FEBRUARY 21.—"Recent Improvements in Agricultural Machinery." By D. PIDGEON. Sir FREDERICK BRAMWELL, F.R.S., will preside.

FEBRUARY 28.—

MARCH 7.—"The History of the Pianoforte.' By A. J. HIPKINS. JOHN STAINER, M.A., Mus. Doc., will preside.

Foreign and Colonial Section.

Tuesday evenings at 8 o'clock:—

January 30.—"Life among the Turcoman Nomads." By Edmond O'Donovan. Lieut.-Col. J. U. Bateman-Champain, R.E., will preside.

February 6.—"Social Conditions and Prospects in Madagascar." By Rev. J. Peill. Sir Donald Currie, K.C.M.G., M.P., will preside.

February 27.—"Egypt, Present and to Come." By Robert W. Felkin.

Applied Chemistry and Physics Section.

Thursday evenings at Eight o'clock:—

February 22.—"Some Causes of Fires and Methods for their Prevention." By Walter G. McMillan, F.C.S.

Indian Section.

Friday evenings at Eight o'clock:—

February 16.—"Overland Commercial Communication between India and China, *viâ* Assam." By Charles H. Lepper. Sir Rutherford Alcock, K.C.B., will preside.

Cantor Lectures.

Monday evenings at Eight o'clock:—

Second Course, on "Solid and Liquid Illuminating Agents." By Leopold Field.

Lecture I.—January 29.

Introduction. Classification of fatty bodies; chemical relationship; ubiquity of their sources. History of lighting. Ancient appliances.

Lecture II.—February 5.

Primary, or unmanufactured materials:—Tallow and Lard. Bee, Myrtle, Japan, and other Waxes. Spermaceti. Palm and Cocoanut oils. Candles from the foregoing. Night-lights.

Lecture III.—February 12.

Colza, Olive, Whale, Sperm, and Fish oils. Mineral oils. Lamps:—The Argand, Moderator, Duplex, and Silber methods. Flashing points. Government restrictions.

Lecture IV.—February 19.

Secondary, or manufactured products. Chevreul's discoveries. Fatty acids; their formation by saponification, distillation, and pressure. Glycerine. Collateral benefits accruing from the Palm oil trade.

Lecture V.—February 26.

Paraffin. History and sources. Outlines of the chief processes of manufacture. Coal-tar products. Paraffin oil. Naphtha. Petroleum.

Lecture VI.—March 5.

Ozokerit, and other mineral sources of light. Manufacture of Candles. Survey of the candle trade and the various inventions and industries excited hereby. Conclusion.

MEETINGS FOR THE ENSUING WEEK.

Monday, Jan. 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Leopold Field, "Solid and Liquid Illuminating Agents." (Lecture I.)

Society of Engineers, 6, Westminster-chambers, S.W., 7½ p.m. Mr. A. T. Walmsley, "Land Surveying and Levelling." (Lecture IV.)

Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on the Paper by Mr. A. D. Clarke, "Improved Farm Homesteads," &c., and on a Supplementary Paper to be read by Mr. C. J. Mann, on "Farm Buildings."

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. 1. The President, "The New Married Women's Property Act." 2. Mr. G. F. Hardy, "The Approximate Summation of Series."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. J. Macdonell, "William Cobbett."

Tuesday, Jan. 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. Edmund O'Donovan, "Life Among the Turcoman Nomads."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. C. Williamson, "Primæval Ancestors of Existing Vegetation." (Lecture III.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. John Fernie, "Mild Steel for the Fire-boxes of Locomotives in the United States."

Wednesday, Jan. 31...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. J. E. Thorold Rogers, "Ensilage in the United States."

Thursday, Feb. 1...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. H. Marshall Ward, "Life History of an Epiphyllous Lichen." 2. Mr. F. Maule Campbell, "Pairing of Spiders and Organs of Male Abdominal Regions."

Chemical, Burlington-house, W., 8 p.m. Professors W. R. E. Hodgkinson and F. E. Matthews, "Some Derivatives of Fluorene."

London Institution, Finsbury-circus, E.C., 7 p.m. Dr. Sparrow Simpson, "The Anthem."

South London Photographic (at the House of the Society of Arts), 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor Dewar, "The Spectroscope and its Applications." Lecture III.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. A. W. Tanner, "The Construction of Theatres."

Archæological Institution, 16, New Burlington-street, W., 4 p.m.

Friday, Feb. 2...Royal United Service Institution, Whitehall-yard, 3 p.m. Captain J. C. R. Colomb, "The Use and Application of the Marines, Past, Present, and Future."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m., Sir William Thomson, "The Size of Atoms."

Geologists' Association, University College, W.C., 7½ p.m. Annual General Meeting and Conversazione.

Philological, University College, W.C., 8 p.m.

Saturday, Feb. 3...Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. Bosworth Smith, "Episodes in the Life of Lord Lawrence." (Lecture III.) Sir John Lawrence and the Mutiny, 1857.

Journal of the Society of Arts.

No. 1,576. Vol. XXXI.

FRIDAY, FEBRUARY 2, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The first lecture of the course on "Solid and Liquid Illuminating Agents," was delivered by Leopold Field, F.C.S., on Monday evening, January 29th. The lecturer commenced with the chemical portion of his subject, giving a classification of the fatty bodies, and pointing out their chemical relationship. He then gave a sketch of the history of lighting from the earliest times, and described some of the appliances formerly in use.

FOREIGN & COLONIAL SECTION.

At the meeting of the Section held on Tuesday evening, January 30th, Lieut.-Col. J. U. Bateman-Champain, R.E, in the chair, a paper was read by Edmond O'Donovan, on "Life among the Turcoman Nomads." A report of the meeting will appear in next week's *Journal*.

PREMIUMS FOR THE 129*th* SESSION.

John Stock Prize.

Under the will of John Stock (1781), funds were bequeathed for the promotion of "Drawing, Sculpture, and Architecture."

A Society's Gold Medal, or £20, is now offered for the best design, from a poem, or from history, or from the Scriptures, prepared with a view to Mural Decoration.

Benjamin Shaw Prize.

Benjamin Shaw, in 1879, presented the Society with a sum of money, the interest of which is applied in Prizes for "Industrial Hygiene."

Under this trust, the following two prizes are now offered :—

1. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the operations of coal-mining."

2. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the manufacture, storage, and transport of explosives."

*** The Council leave it to the competitors to bring the plans under their notice in any way they may think proper, whether by model, written description, or otherwise.

Howard Prize.

Under the will of Thomas Howard (1868), funds were bequeathed for the periodical award of a prize for an Essay on Steam or Motive Power, or for an invention connected therewith. A prize of £100 is now offered for the best Essay on the Utilisation of Electricity for Motive Power. Preference will be given to that Essay which, besides setting forth the theory of the subject, contains records with detailed results of actual working or experiment. The Society reserves the right of publishing the prize essay.

Fothergill Prize.

Under the will of Dr. Fothergill (1821), funds were bequeathed for the offer of Medals for subjects, in the first instance, relating to the Prevention of Fire. A Society's Gold Medal, or £20, is now offered for the best Invention having for its object the Prevention or Extinction of Fires in Theatres, or other places of public amusement.

Mulready Prize.

The Council of the Society hold certain funds, balance of the amount subscribed for a Mulready Memorial, the interest of which is to be expended (amongst other purposes) in providing, occasionally, a medal to be awarded "To that student in a School of Art in the United Kingdom who exhibits the best Drawing from the nude figure, executed in black and red chalk, in the manner so successfully practised by Mulready."

A Society's Gold Medal is now offered under the above conditions.

Designs, plans, models, essays, descriptions, inventions, &c., intended to compete for any of the above Prizes, must be sent in on or

before the 31st October, 1883, to the Secretary of the Society of Arts, John-street, Adelphi, London.

The Council reserve the right of withholding any or all of the above Prizes, or of awarding others of lesser value in their stead, in any case in which there is nothing in their opinior deserving the award, or sufficiently complying with the conditions, sent in for competition.

H. TRUEMAN WOOD, *Secretary*.

LABELS FOR PLANTS.

The Council of the Society of Arts offer a Prize of Five Guineas, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for a Wooden Plant Label, saturated with paraffin, or some other preparation which would preserve the label, and would be likely to keep the writing upon it legible, either with or without the aid of paint, for five years. The labels will be tested by the Committee with the view of ascertaining, as far as can be done in a limited time, whether they would be likely to stand prolonged use. It is believed that satisfactory tests can be made in a month or two.

An additional Prize of Five Guineas has been placed at the disposal of the Council of the Society by Mr E. G. Loder, for the best permanent Border Label suitable for private gardens, the cost of which should not exceed £4 per thousand.

Specimen labels, bearing a number or motto and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society not later than the 1st June, 1883.

Both awards will be made on the recommendation of the Committee appointed for the purpose by the Council.

The Council reserve to themselves the right of withholding the prizes offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

Proceedings of the Society.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, January 25, 1883; Professor H. E. ARMSTRONG, F.R.S., in the chair.

The paper read was—

THE TECHNICAL ASPECTS OF LIGNIFICATION.

BY C. F. CROSS.

The subject upon which I have undertaken to address the Society is one of fundamental importance, whether regarded from the technical or the more purely scientific side. The latter involves the consideration of the plant as the great synthetical laboratory of the natural world, and of cellulose and lignose as the most extensive products of this synthetical activity; on the other hand, cellulose and its lignified derivatives constitute the raw material for what are amongst the most important trades of a civilised community, viz., the manufacture of paper and textile fabrics from vegetable fibrous materials. While, in dealing with this subject, it will be necessary to confine ourselves as closely as possible within the limits expressed by the title, the object contemplated in its selection cannot be compassed with exclusion of theoretical considerations; for it is necessary to show that the methods in general use for the treatment of cellulose substances involve a general principle; and that this principle is the reverse of that which is based rather upon a knowledge of their chemical constitution than upon an empirical observation of certain changes wrought upon them by re-agents, and is, therefore, the foundation of a more rational treatment.

In order to elucidate this central antithesis, it will be necessary to trace, briefly, the development of our present system of cellulose technology. As our chemistry is by nature what we may term a water and oxygen chemistry, so we find that our chemical processes of treating vegetable fibres, for the purpose of adapting them to their finest uses, having been evolved from observation of the action upon them of substances and under conditions the most readily available, are dominated by water and oxygen. In this process of evolution, we mark the following stages:—(1.) The observation of the natural isolation of fibres by the process of dew-retting. The greater number of vegetable fibres used in the arts are obtained from compound structures of which they are constituents. First in order of biological simplicity stands the large group of bast fibres, usually of great length, and, as they occur, ordered into a more or less compact tissue, lying beneath the bark. Next we have the fibrovascular bundles of monocotyledonous plants which are scattered

throughout the cellular matrix of the stems and leaves; and lastly, the biological complex, wood. The fibres of the two first divisions are alone available for textile purposes, and their isolation from the cellular matter with which they are associated, is frequently seen to be accomplished by the natural or unaided process of retting. The ingenuity of man is not slow, even in its earliest phases of development, to take advantage of the materials thus brought to hand, and then to aid nature in bringing these structures in contact with water, under regulated conditions, so as to secure the most advantageous results. The fibrous character of wood is also revealed by the process of dew-retting, and the product, though unavailable for human use, is not lost sight of by the hornet and other insects, who employ it in making their nests.

In the next stage, we may include the manipulation of the isolated fibres into articles of clothing and domestic use, the washing of these in cold water, and, as the result of growing observation, in hot water, with the addition of wood ashes. The prosecution of these processes involves experience of their softening action, together with the bleaching effects of exposure to air and light in the process of drying. An extension of these rudimentary methods will be seen to include our modern processes of scouring cellulose fabrics.

The employment of fibres, isolated from wood, plays no part in the general process of the evolution of this special knowledge, and we must therefore defer its consideration in passing on to the third stage of progress.

The application of chlorine, and subsequently chlorine compounds—the hypochlorites of the several bases—to the bleaching of cellulose substances, completes the chain of development of the natural or oxidation method, which is now firmly and universally established.

It has long been held that the action of these hypochlorites upon the colouring and other adventitious matters which they remove is one of oxidation, and a confirmation of this, if indeed confirmation were needed, is to be found in the recent application of the permanganates to the same end. The practical value of their application, which is well established in respect of simplicity and certainty, will increase with the increasing cheapness of this source of oxygen. To us it is interesting, as completing the demonstration of the foundation of our present system of scouring and bleaching cellulose fabrics uniformly, upon methods which involve the oxidation of their constituents. These processes, which have so long occupied a position regarded as unassailable, have recently come under suspicion, and in their empirical extension to substances other than, and yet similar chemically, to those with which they yielded results of general excellence, have led to observations which suggest the necessity of a revision.

First, in the application of calcium hypochlorite to the bleaching of jute, it was found that, under certain circumstances, chlorine compounds of the fibre constituents were formed. This difficulty, however, was easily overcome by substituting soda for lime; but a second difficulty yet remained in the experience that jute fabrics, bleached by means of the soda compounds, underwent further changes when exposed in the dry state to the atmosphere, and that when such fabrics were steamed, as in the calico printing processes, these changes were intensified, and made evident by considerable discolouration, and often by disintegration; the latter effect requiring, in many cases, a subsequent exposure to the atmosphere of varying duration, for its more complete manifestation. The cause of these phenomena was found to lie in certain constituents of the fibre substance, which have the property of absorbing oxygen to form acids; and an effective remedy was discovered in impregnating the fabrics with alkaline sulphites, the reducing action of which arrested the tendency impressed upon the fibre substances by the oxidising value of the bleaching processes, and the presence of which was found to counteract the disintegrating effects of long exposure and of the action of steam, previously experienced. We must content ourselves with a passing notice of this point, which will be found fully treated elsewhere, in order to give greater prominence to the discussion of the second count in the indictment of the oxidation method of treating vegetable substances for the isolation of cellulose. This is afforded by the history of the process of treating wood for the preparation of paper pulp. These processes have recently advanced to a position of considerable importance, and the experience upon which they have been developed is not only of great interest technically, but throws light upon a number of the recondite problems of plant chemistry. It will be seen, as we proceed, that this experience has been closely similar to that which was worked out in the case of

jute; a fact which is to be regarded not merely as a coincidence, but as the necessary consequence of the close similarity in chemical composition of the substances in question; and the occurrence of similar difficulties, leading to the adoption of similar remedies, as a result, moreover, of altogether independent investigations, will contribute very much to the recognition of the necessity of revising our cellulose technology, upon the principles which they go to establish.

To elucidate these more clearly, it will be necessary to give a brief survey of the chemistry of the compound celluloses from a theoretical point of view, which has been arrived at through a variety of contributory agencies: (1) the conclusions of physiologists with regard to the chemistry of the development of cellulose and its derivatives; (2) the verification by chemical research of these conclusions; and (3) an independent study of cellulose and lignose as isolated individuals.

Cellulose, in the form of bleached cotton, is a well-defined body, the properties and characteristics of which are too familiar to need recapitulation. Bleached linen, on a general presumption of the identity of the celluloses, has been regarded as identical with cotton. The treatment of these fibres, on the other hand, proceeds upon the recognition of considerable differences between them; and while these have not yet found definite chemical expression, they are sufficiently evident to point to the individuality of the members of the group of celluloses. This, we hold, constitutes the only satisfactory basis of their technology. Biologists necessarily ignore these differences, and understand by cellulose a substance having those properties which chemists regard only as typically characteristic; these are chiefly external appearances, and the blue colouration which it gives with Schulze's solution. Such a substance appears to constitute the original form of all plant fibres, as indeed of the skeleton generally; and although varying with the condition of its elaboration and hydration, these variations may be regarded as comparatively unessential. The phenomenon of lignification is superinduced upon this cellulose basis, and, according to recent views, through a process of intrinsic modification. A very simple type of this process, if not the simplest, is to be found in the jute fibre, the chemistry of which, as already indicated, involves to a large extent the chemistry of wood. A recapitulation of its chief properties, parallel with those of cellulose (cotton), will give a concise view of the more conspicuous chemical changes involved in lignification:—

	Cellulose (cotton.)	Lignose (jute.)
1. Carbon-percentage ..	44	47
2. Action of chlorine (moist)	Oxidises.	Oxidises and chlorinates.
3. Action of dil. acids at 70°	Forms hydrocellulose.	Resolves into soluble modification and ultimately furfural, &c.
4. Action of nitric acid ($HNO_3 + H_2SO_4$)	Forms colourlesss explosive compounds	Forms yellow coloured explosive compounds.
5. Re-action with aniline sulphate	Nil.	Yellow colour.
6. Re-action with Schulze's solution..	Blue colour.	Brown colour.

These are the main features of the evidence which goes to show that in the process of lignification the typical characteristics of the original cellulose are maintained; and, moreover, that lignified fibres are not composed of cellulose mixed merely with adventitious or encrusting substances which mask its ordinary re-actions, but that they are made up of cellulose, or a cellulose "residue," in a state of intimate chemical union with molecules, which confer upon them their special features of difference. Of these we may select, as having a more direct bearing upon our subject: (1) the formation of the peculiar aldehyde, known as furfural, under digestion with dilute mineral acids at 60° to 80° C.; and (2) the formation under the action of moist chlorine of chlorine-substitution derivatives, which appear to have close connections with the trihydric phenols. On the latter of these we need say but a few words. Although phenol derivatives are formed from the jute fibre substance, the evidence goes to show that it contains actually no aromatic constituents, no derivatives of such having been obtained by any process of modification other than that of chlorination—or, at least, only in insignificant quantity. Woods, on the other hand, do contain aromatic substances, many in large proportions; of these we may mention many colouring matters, astringents, and glucosides.

The former property, of yielding furfural, and under such conditions as cannot involve any radical chemical change, leads to the very important conclusion that processes for the treatment of lignified fibres, which in any way involve chemical modification, should have strict reference to the aldehyde character

of the substances of which these are built up, or, to express it more correctly, to the fact that the immediate products of the hydrolytic resolution of the lignified celluloses are aldehydes of the furfural type.

The aldehydes, as is well known, represent the intermediate stage of oxidation of an alcohol to its corresponding acid. This essential incompleteness is the cause of their characteristic properties, viz., (1) the avidity with which they combine with oxygen to form acids; (2) tendency of union of like molecules to form polymeric modifications; (3) tendency to synthetical union with other molecules to form complex derivatives, which are frequently coloured and generally resinous in character; (4) tendency to cumulative resolution, or condensation with elimination of the elements of water. These properties confer upon the aldehydes a condition of "chemical tension," which, as has been recently theorised, plays an important part in the synthesis of proteid substances in the living organism; and an extension of this conception of the chemistry of life may reasonably be anticipated in regard to the substances we are considering, and, therefore, to the whole work of building up vegetable structures. We must, however, refrain from a somewhat speculative discussion, and turn to the practical applications of our observations.

The treatment of jute in the manner already described, follows as a simple deduction. The presence of sulphurous acid antagonises the oxidising action of the conditions to which the fibre is subjected, exposure to which is otherwise extremely prejudicial, inducing decomposition in the manner already described.

Of much greater practical importance, however, are the processes for treating wood and other resistant vegetable substances for the preparation of paper pulp, and the modifications of these, which we can show to follow from what is known of the composition of these fibrous structures. Up to within a comparatively recent period, these processes have consisted uniformly in a drastic treatment with alkaline solutions; the process of boiling under pressure with caustic soda, originally applied by Routledge to esparto, has been generally extended and adopted, and is, indeed, the standard method of treating lignified substances for paper-making; efforts to substitute this process by one based upon the principle of reduction or anti-oxidation have been made by one or two technologists, who, at the same time, do not appear to have approached the subject from the same point of view. The subject appears to me to have been developed most consistently by Fry and Ekman, and as their labours have had strict reference to the principles under discussion, their treatment will occupy the prior place.

Fry commenced the investigation of this subject about 17 years ago. He was familiar with Houghton's process, the object of which was to throw the work of disintegrating the wood upon the agencies other than the alkali, which latter it was found could be proportionately reduced in quantity. Fry was led to investigate the resolving action of the water alone, under the guidance, not unworthy of mention, of a passage in Faraday's "Manipulation," which directs the chemist, in analysing a mixture, to adhere to the method of preliminary separation by means of solvents successively applied, of these water being the first. It was found that water, at a sufficiently high temperature and pressure (70 lbs. of steam), exerted a very considerable disintegrating action, sufficiently indeed to produce a pulp well adapted to the manufacture of brown paper; also that of the soluble products of resolution a large proportion were acid bodies. The following statistics, having reference to the two processes, are worth reproduction, the wood operated upon being in both cases that of the common *Pinus Sylvestris*:—

(1.) *Houghton Process.*—5,378 parts (dry) wood, yielded 1,787 parts dry pulp = 33 per cent.

(2.) *Water Process.*—6,338 parts (dry) wood, yielded 4,424 parts dry pulp = 70 per cent.

To neutralise the solution from the boiling (2), 1,000 parts $Na_2CO_3 10H_2O$ = 216·8 parts Na_2O were required. The acids formed in such large quantities were partly volatile, *i.e.*, of low molecular weight, and derived from the substituting or side groups in the original molecule of the wood substance, and partly acids of high molecular weight, exhibiting derivation rather from the central nuclear carbohydrate group.

These acids are formed by the hydrolytic resolution of the wood substance, accompanied by oxidation at the expense of atmospheric oxygen, or it may be also of oxygen derived from other portions of the wood substance itself. It is also evident that the acids, when formed, must react on further portions of the wood substance, and aid in its resolution and disintegration.

A number of the by-products obtained in this process were also investigated. It has already been stated that the chemical consti-

tution of wood is, in the main, identical with that of jute; this identity we may express more precisely as limited to the ground substance of the wood; and the decomposition of this by the action of the superheated water, gives rise to some quantity of furfural and other aldehydes, which were collected, in Fry's experiment, by means of an elaborate condensing arrangement. These aldehydes were accompanied by a number of other volatile products, boiling below 100° C., which have not yet been fully investigated. These are derived partly from the ground substance, and partly from the resinous and other characteristic constituents of the wood, which may be considered as distinct from the ground substance. With regard to the aromatic substances, in the presence of which the woods show a further distinction from the bast fibres, these were so far complicated by combination with the aldehydes which are formed during the process, as to be in a condition altogether unfit for investigation.

As regards the resolution of their ground substance, or lignose, as it is termed, the woods resemble very closely the jute fibre, and those substances which are allied to it. A comparison of these fibres with one another, in relation to the action of superheated steam upon them, and the per-centage of their substance thereby converted into soluble products, has been made by Dr. Forbes Watson, with the results contained in the table on page 225.

The interesting point to be noted is that the loss per cent. follows the order of the fibres, in respect of lignification. Although these investigations were not extended to woods, it is known from other sources that their behaviour affords an additional proof of this statement.

The process of disintegrating the wood by means of water, at elevated temperatures, was worked to a practical issue, and a mill was put up at Bergvik, in Sweden, for the manufacture of "half-stuff" for brown paper. At the same time, investigations were continuously prosecuted with the view to increase the solvent action of the water, and thus to arrive at a product more nearly approaching cellulose. It became more and more evident that the condition of oxidation was especially inimical to this end, and to antagonise it by the presence of a reducing agent was the purpose which underlay the next series of experiments. These were carried out by Ekman, and his choice of a reducing agent soon fell upon sulphurous acid, a choice, which was perhaps, in the first instance, determined by a natural fitness on the side of economy, but is now seen to have the more important function conditioned by the peculiar relationship of the sulphites to the aldehyde-products of resolution of lignose. The results which followed from this modification, the removal of a further 20 per cent. of the non-cellulose constituents of the wood, and the production of a residue which is but little removed from pure cellulose, are now matters of common knowledge. The special commercial advantages which this process offers, viz., the power to employ a raw material at £2–3 per ton, from which 40 to 50 per cent. of a pulp is obtainable, suitable for all classes of paper; the use of re-agents of little cost; and the production of a solution of the non-cellulose constituents, from which, doubtless, valuable products are to be isolated, or which, at least, will cause no detriment to the water-courses into which it may be run, are sufficiently obvious to have already commanded considerable attention from practical men.

The Ekman process differs from the water process, in the sole particular of the presence of the magnesium sulphite; and the function of this salt appears to be, not so much to aid positively in the resolution of the wood, as to prevent the degradation of its constituents in virtue of the reducing activity of its sulphurous acid, and the property of the entire salt of forming compounds with certain of the non-cellulose constituents which enter into solution. In other words, the water, at the elevated temperature at which it is employed, appears to be the effective solvent; but while, under ordinary circumstances, this solvent action reaches a limit determined by the formation (by way of oxidation and synthetical combination) of secondary derivatives, which resist the solution, these secondary changes are obviated by the presence of the sulphite, and the resolving action of the water is allowed to proceed unimpeded.

Other processes for resolving wood by means of solutions of sulphites have been patented, and worked with more or less success. Upon the exclusively practical question of deciding as to the relative merits of these, it is not for us to speak. We may, however, inquire from what point of view their originators have investigated the matter, and therefore, so far as a study of their specifications will permit, to what extent they contribute to the establishment of the general principle upon which they proceed.

In 1866, Tilghman patented a process for

TABLE

SHOWING THE COMPARATIVE RESISTING POWER OF VARIOUS INDIAN AND SOME OTHER FIBRES UNDER THE ACTION OF HIGH-PRESSURE STEAM AND BOILING WATER.

(Fibres arranged in order of effect produced, commencing with those least influenced.)

EXPERIMENT No. I.			EXPERIMENT No. II.			FIBRES ARRANGED IN ORDER OF TOTAL LOSS PRODUCED BY BOTH EXPERIMENTS.		
No.	Name.	Loss per cent. after exposure for two hours in steam, at 15lbs. extra pressure, followed by boiling in water (212°) for three hours.	No.	Name.	Loss per cent. after further exposure, for four hours, to steam and water at 15 lbs. extra pressure.*	No.	Name.	Total loss per cent.
1	Himalayan Hemp† (*Cannabis sativa ?*)	0·58	1	China Nettle	None.	1	Himalayan Hemp†	0·77
2	Rheea (*Boehmeria nivea*)	0·81	2	Neilgherry Nettle	None.	2	China Nettle	0·89
3	China Grass (*Boehmeria nivea*)	0·89	3	Sunn	None.	3	Rheea	1·58
4	Ambaree (*Hibiscus cannabinus*)	2·39	4	Himalayan Hemp†	0·19	4	Neilgherry Nettle	2·85
5	Flax (*Linum usitassimum*)	2·47	5	Ejoo	0·61	5	Sunn	2·93
6	Pine Apple (*Ananassa sativa*)	2·47	6	Rheea	0·70	6	Flax	3·50
7	New Zealand Flax (*Phormium tenax*)	2·70	7	Flax	1·03	7	Ambaree	3·63
8	Pita or Agave (*Agave Americana*)	2·72	8	Bedolee Sutta	1·20	8	Ejoo	4·15
9	Sufet Bariala (*Sida rhomboidea*)	2·76	9	Ambaree	1·24	9	Bedolee Sutta	4·26
10	Neilgherry Nettle (*Urtica heterophylla*)	2·85	10	Moorva or Marool	2·03	10	Muddar or Yercum	5·47
11	Sunn (*Crotalaria juncea*)	2·93	11	Dunchee	2·18	11	Pita or Agave	5·55
12	Bedolee Sutta (*Pederia fœtida*)	3·66	12	Jute	2·19	12	Moorva or Marool	5·55
13	Muddar or Yercum (*Calotropis gigantea*)	3·19	13	Muddar or Yercum	2·28	13	Sufet Bariala	6·00
14	Italian Hemp (*Cannabis sativa*)	3·38	14	Coir	2·54	14	Dunchee	6·07
15	Manilla Hemp (*Musa textilis*)	3·38	15	Manilla Hemp	2·69	15	Manilla Hemp	6·07
16	Plantain (*Musa paradisiaca*)	3·40	16	Italian Hemp	2·86	16	New Zealand Flax	6·14
17	Russian Hemp (*Cannabis sativa*)	3·47	17	Pita or Agave	2·83	17	Italian Hemp	6·18
18	Ejoo (*Arenga saccharifera*)	3·55	18	Sufet Bariala	3·24	18	Pine Apple	6·49
19	Moorva or Marool (*Sanseviera zeylandica*)	3·72	19	Plantain	3·34	19	Plantain	6·74
20	Dunchee (*Sesbania aculeata*)	3·89	20	New Zealand Flax	3·44	20	Coir	8·13
21	Yucca or Adam's Needle (*Yucca gloriosa*)	5·30	21	Pine Apple	4·02	21	Russian Hemp	8·44
22	Coir (*Cocos nucifera*)	5·59	22	Russian Hemp	4·97	22	Yucca or Adam's Needle	10·87
23	Pandanus or Screw-pine‡ (*Pandanus odoratissimus*)	6·03	23	Yucca or Adam's Needle	5·57	23	Pandanus or Screw-pine	12·21
24	Jute (*Corchorus olitorius; C. capsularis*)	19·20	24	Pandanus or Screw-pine	6·18	24	Jute	21·30

* In this case, the samples were partially immersed in the water, and the operation of boiling afterwards, to remove the portions loosened by the steam, was not required. In Experiment No. I, the fibres were placed entirely in the steam, then removed and boiled for three hours in water.

† Although, after careful examination, this is believed to be true hemp, still, looking to the very high place which it takes, as compared with that from Russia and Italy, it is quite possible that this opinion may be wrong. It will be noticed that Sunn fibre, which stands 11th in Experiment No. I, occupies the first rank in No. II. This "Himalayan hemp" is not the produce of a nettle, but it may, as originally suggested by Mr. Henry Cope, be that of the Sunn plant.

‡ This refers to the white, comparatively weak fibres, furnished by the leaves of the Screw-pine, not to the fibrous material yielded by the aerial roots which shoot downwards from its stem.

the preparation of paper pulp from wood, by heating with sulphurous acid solution, with or without a base, and at a pressure not exceeding that of the atmosphere. In his specification he builds upon two properties of this reagent as especially contributing to the result, viz. :—(1) Its bleaching action upon vegetable as upon animal tissues; and (2) its specific action as an acid upon the constituents of the wood. This point of view involves no general theory of the chemical function of the substances operated upon; and the want of success which attended Tilghman's work is referable partly to their somewhat inadequate conception of the theoretical basis of his process. Augustus Mitscherlich took out in 1874, a German patent for treating wood with a solution of bi-sulphite of lime, and his process has met with considerable success. This chemist, in his specification, wisely avoids theoretical matters; at the same time, from the statement which it contains that the yield of cellulose from *Pinus Sylvestris* amounts to 66 per cent. of the weight of the wood, we are enabled to gather (1) that he effects a very incomplete resolution of the wood substance, not much more, indeed, than by means of water at the same temperature as that employed by him; and (2) that he attaches a very different meaning to the term cellulose from that which is current amongst chemists who have investigated this subject from the more purely theoretical point of view. We cannot see, therefore, that either of these processes was instituted upon a clear recognition of the chemical relationship of the reagents. The process also, which bears the name of Francke, is one which addresses itself rather to the main practical end of converting wood into paper pulp, than to the establishment of a general principle, and, therefore, can only claim from us this passing notice.

Whatever be the minor issues of these several processes in their competition one with the other, they all offer a solution of the problem of preparing paper-pulp from wood under reducing conditions, and constitute, therefore, together with the many obvious points of superiority of the products, both soluble and undissolved, and of its results, economically considered, a very strong indictment of the older methods; added to which, the confirmatory evidence drawn from the theoretical investigations of the constitution of lignified tissues, makes the case for the sulphite method complete.

I must not omit to mention that there has been hitherto a practical objection to this process, which has been of sufficient weight to deter many from adopting it, who were on other grounds fully satisfied as to its superiority —this lay in the necessity of using a lead-lined jacketted boiler, a very costly piece of apparatus in the first instance, and one very liable in the next place to get out of order by displacement of the lining, and thus to cause serious interruptions. It has only recently become known to those engaged in developing this process, that a metal has been in use now for several years, in the process of manufacturing glucose, which resists the action of dilute sulphuric acid boiling under pressure, and fulfils all the conditions demanded by the sulphite process for wood-pulp. Its adoption removes the only serious objection which could be urged against the many advantages which it offers.

Although we refrain from giving an opinion upon the relative values of the pulps produced by the several sulphite processes, it may aid in the formation of a correct estimate by those who have not given much attention to the theoretical side of the subject, to give a short account of the three chemical tests which afford the most valuable criterion of a pulp, apart from a direct observation of its working into paper. It is evident that its value increases in proportion as it approaches more nearly to the condition of pure cellulose. To detect residual lignose (1) the aniline sulphate test (yellow reaction) has been considered sufficient; but it must be pointed out that the "reduced" pulp often fails to give the reaction, even though it contain a large proportion of lignose, and that the only reliable test is (2) exposure to chlorine gas, followed by immersion in a solution of sodium sulphite, the lignose substances being hereby converted into a bright magenta-coloured derivative. The most reliable method is, however (3), the quantitative estimation of the cellulose by any of the standard methods, together with an observation of the behaviour of the cellulose in regard to boiling alkaline solutions, chiefly the loss in weight sustained on boiling in a solution of potash of standard strength for a constant interval of time. In regard to the latter test, it serves to reveal a very serious defect of some boiling processes, or of any boiling process improperly conducted, viz., the modification of a portion of the cellulose into derivatives having a gelatinous character or tendency, and which render a paper in which they are present brittle and hard. This modification is the result or the expression of a "hydration" of the cellulose,

and appears to depend, to a great extent, upon the proportion of base to acid in the sulphite solution. The products in question are soluble in alkaline solutions, and thus the value of the test in revealing a defect which might otherwise be overlooked. Time will not permit us to discuss this question of wood boiling more fully.

In conclusion, we must devote a few words to the cognate subject of the isolation of fibres by means of "retting." This process is one that requires most delicate handling, and that whether the fibres to be separated are of the lignified (jute) or cellulosic type (flax, hemp). Those who are acquainted with the details of the conduct of this process will have been struck with the fact that it continues to be be regulated by a traditional empiricism, that, for instance, a product of such great value and importance as flax should be left to the uncertain issues of a process which is calculated to do more or less damage to the fibre, according to variations in conditions which are only very imperfectly understood, and therefore controlled. It has been found, on the other hand, that these fibres can be isolated by means of the process of boiling, under pressure, with solutions of the sulphites, with results which have the great merit of being invariable. The process is simple, and capable of endless variation to suit the special circumstances of any given fibre. In this application, it is, as yet, only in its infancy; but the superior results which it promises call for the careful consideration of practical men, both agriculturists and manufacturers. When it is remembered that huge industries depend upon a first process of an essentially uncertain character; that the raw material which they employ is probably all, more or less, deteriorated by this process; and further, that the difficulties of dealing with the produce stands in the way of developments in agriculture, which might have an important influence on the future of this country, it is surely time that the matter received a thorough investigation.

DISCUSSION.

The CHAIRMAN said Mr. Cross entitled his paper "Technical Aspects of Lignification," but it was mainly directed to the set of changes which occurred in "delignification." The point mainly to be discussed was the success of the various processes to which he had referred for converting such a very common and cheap material as ordinary wood into paper. The chief questions of interest were the character of the fibre produced by the various processes, the yield, the cost, and the use made of the sulphites to which the author had alluded. Although, no doubt, sulphites generally would exercise a protecting action, chemists knew that often very minute differences, such as would exist between the various sulphites, might be of most material importance in cases of this kind.

Mr. GEORGE FRY said there was one point to which Mr. Cross had not referred, on which he might say a word. He wanted to satisfy himself some years ago that the chlorine process was actually a process of oxidation; he, therefore, made the following experiment. He treated wood with water at high pressure, and after washing the fibre thoroughly, obtained the brown pulp shown on the table; he then took this pulp and treated it with a dilute solution of nitric acid, and warmed it gently; he thus got an oxidation of the brown colouring matter by the decomposition of the nitric acid. He then treated the pulp with an alkali, and washed away that part of the encrusting matter which was soluble, and by repeating the process several times, got at last a cellulose which was virtually pure, but not white; it was a grey colour; under the microscope it appeared colourless, and in order to produce the white colour shown in the other specimen it had to be treated with chlorine. That was an interesting experiment, as showing clearly that the solubility of the encrusting matter was purely due to oxidation. As to the yield of pulp by the different processes, Mr. Cross had told them that if wood were boiled with a caustic alkali, at high pressure, you got, in the main, a yield of 33 per cent. He was interested to see the result if he first boiled the wood in water, at high pressure, and afterwards treated it at high pressure with caustic alkali; he should have obtained the same quantity of cellulose which he would have obtained if he had treated the wood direct with the caustic alkali, but he found to his surprise that the yield obtained was considerably less, being not more than 25 or 26 per cent. By the present process, however, they obtained a yield of something like 48 to 50 per cent. He was, therefore, of opinion that in both the alkali process, and in the process of first boiling with water, and then treating with alkali, there was a solution of the cellulose in some way or other.

The CHAIRMAN said the specimens of jute which had been exhibited illustrated, in the most striking manner possible, the extraordinary influence of this method of preserving fibre. He should like to ask Mr. Cross to what extent the jute fibre was protected by impregnation with sulphite. He had told them that the two specimens differed in that one was impregnated with sulphite before being steamed, whilst the other was not. The one had not merely retained its colour, but had also preserved its strength, and he should like to know to what extent did that preservation hold good; how long a time the jute fibre was protected by the sulphite from the change which took place when it was subjected to steaming. Mr.

Cross had very clearly stated the theory on which the action of the sulphite depended. It seemed, at first sight, to be a mere bleaching process, but the recognition of the theory of the action was very important. Mr. Cross had put forward, in very plain terms, a statement, that amongst the products of decomposition of those bodies of which wood was made up, there occurred aldehydes and other bodies which were excessively prone to enter into reactions with each other, not merely to undergo oxidation, but, so to speak, to couple up. Magnesium and other sulphites seemed not merely to exercise a reducing action, but to a large extent to prevent that class of reactions which chemists frequently spoke of as "condensations." The paper was not at all an easy one to understand from the popular point of view, but required careful study, and contained many points which, he believed on consideration, would prove to be of considerable importance. A great deal was stated which was theoretically important, and deserved the most careful attention of the manufacturer. He should be glad to have from Mr. Cross further information with regard to the practical working of the processes described, more particularly with regard to the character of the fibre produced by this method of treatment, and also with regard to the action of various sulphites.

Mr. Cross said the Chairman reminded him that perhaps his paper had not been cast in quite the proper mould for such a meeting, but the subject was one he could not very well compromise. There were certain facts which he was bound to lay down. Of course, if he had had the means of making a few experiments, some of the properties of the aldedydes might have been made evident, and the complication of the molecules which actually takes place in this process of boiling, could have been demonstrated. The subject was somewhat new, and he did not know that every technologist was yet exactly in a position to assimilate all that had been said. Still he believed he had shown that there was a necessity for understanding these substances, and that must be his apology for having made his paper less popular than perhaps he ought to have made it. It was not going too far to say that this question of the condition of plant substances, and particularly the chemical activity of the bodies in which they tended to be resolved by this simplest of all agencies, viz., the hydrolytic, must occupy an increasing position in all processes, which had to do with the use of plant substances; and he might say that he had endeavoured to state the matter in the simpliest and least complicated way possible. Dr. Armstrong had asked how far the protection to jute fabrics would extend. Those two cloths, when taken from the steam chest, offered a very peculiar contrast, one having gone perfectly brown, while the other had retained its colour; on the other hand there was no apparent loss of strength in the brown piece, and that showed how subtly the influences which produced disintegration operated. Those fabrics were both, as far as he could test, equally strong when removed from the steamer, but after an exposure of about three weeks the former had no strength at all, whilst the other retained its strength, showing that its destruction, begun in the steam chest, required consummation. Those who first worked the process in question produced a lot of printed curtains from jute, which, to all appearance, were perfectly good, and found their way into commerce, but, after being exposed to the air for a few weeks, became totally disintegrated. Similar instances occurred in the case of dry rot in wood. These, no doubt, were expressions of the subtle condition of the matter of which they were composed. The changes occurred subsequently to the initial oxidation, and that was the case which made it impossible to anticipate the failure which attended the application of these things in the first instance. With regard to the action of the different sulphites in wood boiling, there was no doubt they had special activities, and also that they fulfilled a second function that is to say, not merely the keeping up of a reducing condition in the boiler, but the gradual formation of compounds with the substances which were dissolved, thus aiding in the resolution of the parent substances. They knew from experiments, the full results of which they were not yet in a position to lay before the Society, that these bodies entered into combination, for magnesium sulphites could be got out of the by-product, as magnesium sulphite double compounds. The different sulphites had different activities, no doubt, ammonium, sodium calcium, and magnesium sulphites, each had their special action; and, as far as he could see, the best adapted on every consideration, whether economical or chemical, to the resolution of these substances, was the magnesium sulphite. The subject he had lastly touched upon was one that he knew would attract a good deal of attention if the paper had been read in a centre where these industries were carried on. Everybody marvelled at the present condition of the flax industry in Ireland, which permitted every little farmer who grew his few rods of flax, independently to prepare it for the market; this explained the complicated process of sorting the flax, and why the inferior sorts were, to a large extent, inferior by reason of imperfect retting. This industry was in a condition which seemed almost to be a slur on a country which pretended to any scientific knowledge of the subject, and so, no doubt, was the jute industry in India. All the jute which found its way to this country was, no doubt, very largely deteriorated from the condition in which it was first retted. If these subjects were to attract the attention of practical men, they would see the necessity of harvesting and treating the produce on such a basis as should secure absolute uniformity and certainty of results. If the sulphite process of boiling came to be generally recognised, it would give considerable scope to the growing of crops in this country,

which would be invaluable. One did not see that there was any reason why flax should not be grown largely. If there were a certain easy method of getting the fibres, whether for paper-making or textile purposes, a stimulus would be given to the agriculture of the country. No crop was easier to grow than flax, and he thought its production in a larger quantity would be of great value. In conclusion, he said there were a number of specimens on the table which he should be glad to give any information upon, if desired.

The CHAIRMAN then proposed a vote of thanks to Mr. Cross for his paper, which was carried unanimously, and the meeting then adjourned.

NINTH ORDINARY MEETING.

Wednesday, January 31, 1883; Sir B. T. BRANDRETH GIBBS in the chair.

The following candidates were proposed for election as members of the Society:—

Albright, G. S., Phosphorus and Chemical Works, Oldbury, near Birmingham.
Bonham, Sir George Francis, Bart., Knowle-park, Cranleigh, Guildford.
Browne, Lennox, 36, Weymouth-street, W.
Edwards, E. Price, Trinity-house, E.C.
Love, William, 21, St. Helen's-place, E.C.
Matthews, James, 23, New-street-square, E.C.
Musgrove, Hubert Musgrove, Barrow-in-Furness.
Rundall, Lieut.-General F. H., R.E., C.S.I., Limehurst, Spring-grove, Isleworth.

The following candidates were balloted for and duly elected members of the Society:—

Bailey-Denton, Eardley F., 22, Whitehall-place, S.W.
Belfield, Reginald, Llyndally, 1, Palace-road, Streatham-hill, S.W., and Phœnix Electric Light Company, 4, George-street, Hanover-square, W.
Blyth, Philip T., 17, Gracechurch-street, E.C.
Brown, John, 23, Whitefriars-street, E.C.
Bruce, Gainsford, 2, Harcourt-buildings, Temple, E.C.
Clark, William Henry, Merton Abbey, Merton, Surrey.
Clutton, William James, The Mount, York.
Cruickshank, Arthur B., The Grand Hotel, Charing-cross, S.W.
Dash, Thomas Alexis, The Hollies, Feltham, Middlesex.
Goulden, Thomas, 55, Millbank-street, S.W.
Gray, William Lewis, 36, Gutter-lane, E.C.
Henderson, Alexander Lamont, 277, Lewisham-road, S.E.
Isaac, Leon Joseph, 10, Adelphi-terrace, W.C.
Jonas, Joseph, Continental Steel Works, Sheffield.
Lindley, Joseph, Blittersdorffs Platz, 29, Frankfort-on-Main.
Lloyd, David, 15, Motcomb-st., Belgrave-sq., S.W.
Medhurst, John Thomas, 124, Narrow-street, Limehouse, E.
Moon, William, 67, Moray-road, Tollington-pk., N.
Morgan, James Henry, 124, Narrow-street, Limehouse, E.
Phillips, William Alfred, Electrical Works, Wharf-road, Hackney-wick, E.
Powell, Miss, Ottawa-lodge, Guildford, Surrey.
Roe, James Elphinstone, Margan-lodge, Fulham-park, S.W.
Sim, Lieut.-Colonel Edward Coysgarne, R.E., 32, James-street, Buckingham-gate, S.W., and Shorncliffe.
Turner, Walter William, 31, Malpas-road, Brockley, S.E.

The paper read was—

ENSILAGE IN THE UNITED STATES.

BY PROF. JAMES E. THOROLD ROGERS, M.P.

Having been invited by the Secretary to the Society of Arts to make some statement as to what I have seen of ensilage in the United States, and of the economical advantages which have followed, by unanimous testimony, from its use, I am glad to comply. I must, indeed, allow that I do not pretend to any practical acquaintance with the subject, and that I have only observed and collected evidence. But as an economist, I am profoundly interested in anything which assists the progress of agriculture, as I know that it is possible, according to the success with which agriculture is practised, that a greater amount of human labour can be devoted to other callings than that of procuring food, and that it is on the efficiency and prospects of agriculture that the most important of industries, the home trades, depend. As a student of agricultural history, who has traced its course from the beginning in England down to the latest times, I am largely interested in what appears to me to be the greatest, and, at the same time, the simplest invention of modern times; and, as a public man, I am anxious to ventilate in England what seems to me to be, from the merely industrial side of the question, the fairest prospect for the restoration to prosperity of all those classes which are generally called the agricultural interests.

Ensilage, or the process by which green forage is stored in air-tight and water-tight pits, and pressed down by weights laid on the surface of the mass, was the discovery of M.

Goffart, a French gentleman, who cultivates his own estate at Sologne, near Orleans. He was led to the experiments, which were finally crowned with complete success, by noticing the prodigious economical loss which takes place when green fodder is converted into hay; even when the sun is bright, the forage takes no wet, and it is housed in the best possible condition. It may be that the analysis of the agricultural chemist can discover no difference, except in the matter of moisture, between sound hay and good grass. But the experience of the practical farmer informs him that the economical difference is enormous, that fresh forage gives abundant milk and fine flavoured butter, while hay, even though largely supplemented with corn and analogous food, gives scanty milk and flavourless butter. M. Goffart, therefore, concluded that some change for the worse, possibly undiscoverable by analysis, takes place in the process of converting grass into hay, and that it was well worth while to try whether some means could not be discovered for keeping grass as nearly as possible in its natural state. The result was that he stored his forage in silos, and found that he had succeeded.

From time immemorial, it has been the practice with many nations to store corn, threshed or unthreshed, in dry underground pits. I am well aware that the origin of the practice was to secure produce from marauders. In course of time, it was found that the produce was wonderfully preserved through a long space of time, and the Latin writers on husbandry state that grain was kept unchanged in them for incredible periods. Thus, according to Columella, wheat was preserved unharmed for fifty years, millet for more than a century; while Pliny goes so far as to say that beans in the pod were found uninjured after 220 years. The name given to these pits in Greek is Σειρὸς or Σιρός, in Latin, *sirus*. The Romance languages changed this word into silo, a word found in French, Italian, and Spanish. From this word M. Goffart constructed his term ensilage.

About five years ago, an American, who happened to be in Paris, saw M. Goffart's work on the "Ensilage of Maize," bought it, read it, and, struck with its importance, translated it into English, and published it in New York. Mr. Brown's book instantly attracted readers, and as rapidly suggested experiments. A Mr. Mills, of Pompton, in New Jersey, had already hit on the expedient, though by accident, and in the rudest form. He had attempted to cross a common maize with a late-ripening southern kind, and, as might have been expected, the experiment failed. Convinced that, as the frost was coming on, he should lose his crop, he hit on a desperate expedient. He dug a number of deep trenches in the river bank—it is about twenty feet higher than the level of the stream—cut down the unripe crop, carted it into these trenches, put a light layer of straw on, heaped earth over the straw, and left the crop to take its chance. In the spring he opened the trenches, found the fodder perfectly sound, and fed his horses on it. Since this time he has constructed proper silos, and is an enthusiastic advocate of the new system. I visited his farm, and had a lengthy conservation with him on the subject. It was from Mr. Mills that the first information on the subject reached England, through Mr. Drummond, the Secretary of Legation at Washington, who described the process adopted by Mr. Mills, in a report sent according to custom, last year, and printed among the Government papers. When it reached me, in the ordinary course of distribution among members of Parliament, I determined, having then in contemplation a visit to the United States, to examine the process for myself.

Mr. Brown's translation of Goffart's work was immediately appreciated. The agricultural depression of the Eastern and Middle States of the American Union has been, and still is, far more serious than anything of which we have experience in England. The agriculturists of Eastern America are, with very few exceptions, small freeholders, farming at rack-rent being practically unknown in America. They till a soil which is absolutely detestable, except in a very few highly favoured valleys. It is generally a coarse gravel formed from the breaking down of primitive rocks, the agent being probably frost. The fields are constantly studded by enormous boulders or projecting rocks. The rivers do not warp the land, for the rock refuses to be abraded; and a stream in full flood is as clear as ever. A very large area is, and will remain, primeval forest, for it is nothing but rock, in the cracks of which the trees grow. The rainfall is about 46 inches a-year in the New England and Middle States. When the Union was confined to the sea coast, the Northern States must have had a fierce struggle for existence; and even now the parsimony of the small freeholder in Eastern America has hardly a parallel, except in France, and parts of Ger-

many. Every one says that a peasant proprietor in the Eastern States is worse off than a day labourer, and that a day labourer's condition deteriorates when he purchases a farm with the savings of his wages. The most amazing thing is, that having vast political power in his hands, he is strangely patient under protectionist pillage.

Upon this sterile soil and its poor products comes the full force of Western competition. Freight is far cheaper in the United States than it is in England, the war of rates is recurrent, and the country is constantly being opened up by new routes. But even under these circumstances there is a vigorous agitation against railway rates, a demand that transit on the canals, for example that from the lakes to the Hudson, should be freed from toll, and that greater facilities should be given for the transit of Western produce. This is the claim of what is called the anti-monopoly party. The great towns on the coast are the market of the small farmers for dairy and garden produce. The latter is very cheap, so cheap that country gentlemen find it cheaper to buy than to grow fruit and vegetables.

Cow-keeping is the principal occupation of the New England farmer. Every one, however, with whom I have conversed, assures me that, under the old system of feeding on green grass in the summer, hay and corn or other nitrogenous food in the winter, the farmer gets nothing but the manure for his pains, and has even to pay for that. Many competent persons told me that, under chemical analysis, the New England soil yielded the elements of fertility, but that these were very imperfectly, if at all, appropriated by vegetable growths. Artificial manures, they alleged, were too costly —perhaps, as in other matters, the farmer is fleeced by the protective system—and could in no case supersede farm manure. To have any heart in his land, the farmer must employ the produce of his cow-house and stable—and I can testify to the care with which they save that which many English farmers allow to waste—and, therefore, if he will or no, he must keep cows, though he loses by them. The yearly cost of keeping a cow in the Eastern and Middle States is said to be 80 dols. 30 cents. at least, and to be frequently 94 dols. 90 cents. In order to secure the lowest of these sums, the cow should produce, at the prices paid for milk at the farm, 5,500 lbs. of milk annually. There is not one herd of cows in fifty which produces, on an average, as much as 5,000 lbs. a year per head.

The cause of this loss is the prodigious cost of winter feeding on hay and corn. There is an impression that winter roots are not grown in America. The opinion is incorrect. I have seen fine fields of turnips, swedes, and carrots, but I admit that roots are not a stock crop in the States. The reason, I suspect, is two-fold. Indian corn is a safer, and, estimated by its nutritive properties, a weightier crop than roots would be, and the storage of roots in the winter is a serious difficulty in a country where the winter is so exceedingly severe. The ordinary food of cattle in winter is hay and corn stover, *i.e.*, the straw of maize, supplemented in the case of milch cows, as I have already stated. Ordinarily, it takes the produce of from two to two-and-a-half acres to keep a single head of cattle in New England and the Middle States.

Those who have practised ensilage tell me, with absolute uniformity, that, in the first place, they can maintain in perfectly good condition, as cheaply in winter as in summer, two cows an acre on that land which is employed for ensilaged crops. They affirm that they can produce from thirty to fifty tons an acre annually of green forage, which loses only 5 per cent. of its weight in silo, and is bettered, as compared with freshly-cut forage, by 10 per cent., in consequence of being stored. The American ton is 2,000 lbs. I got distinct evidence of this from a farm in Massachusets, some dozen miles from Boston. Eighty cows were kept for a year on the produce of thirty-four acres of ensilaged rye and maize, both kinds of forage being cut when the plant was in flower. The cows yielded as abundant a flow of milk, and as good a quality of butter in mid-winter as they did in mid-summer, and at less than half the cost of a scantier quantity of milk and a smaller and inferior yield of butter, under the old system. My informant kept a gigantic hotel at Boston. All the milk and butter consumed at this hotel was the produce of the eighty cows, and the thirty-four acres. On another farm, the produce of less than a hundred acres of ensilaged fodder, were kept a hundred and fifty head of cattle, a hundred sheep, and a hundred hogs, all in perfect health and condition, for the herd was the best lot of pedigree Jerseys that I have ever seen.

The possibility of keeping so large a number of animals on land cultivated for ensilaged products, enables the farmer to greatly enrich the rest of his holding. As a rule, he could devote about one-third of his cultivable land (American farms are nearly always what we

should call small, even when possessed by wealthy people) to ensilage crops, and grow hay and oats on some of the rest. I have stated that, ordinarily, an American farmer preserves—carefully guarding it against deterioration—all the manure of his farm; you will never see it left out of doors for the weather to waste or weaken. But I have noticed in one or two ensilage farms a disposition to become indifferent, in some degree, to this economy, or not to insist on it so carefully. Still, I have never seen, in studying the agriculture of several countries, any in which the adage, "muck is money," is more thoroughly appreciated than in the Eastern States of the Union. During the long drought of 1881, which lasted in this district from July to the middle of October, the ministers of the several churches prayed earnestly for rain. "But," said a Connecticut farmer to me, when talking about the toils of his ungrateful calling, "I told our minister, 'It is no use praying for rain in this country; you should pray for manure.'"

Agriculturists who practise ensilage generally contrive to get two crops annually from the same ground. The favourite crops are rye and corn. The rye is sown in the autumn, before the frost sets in; during winter it is manured; it is cut and put into silos by the end of May, the ground ploughed again, and sown with Indian corn; this is again cut as soon as it is in full flower. Some farmers to whom I spoke were a little afraid of rye, in consequence of the risk of ergot, and consequent peril to their breeding cows. Others were of opinion that this risk did not arise till the seed was formed; and all are convinced that forage is most nutritious throughout, and most serviceable for cattle, when the plant is in flower, and that it begins to deteriorate as soon as ever the seed begins to form. Twenty tons of corn forage, and seven tons of green rye to the acre, are deemed moderate crops.

That corn or maize is the commonest, and will remain the most frequently ensilaged crop, cannot be doubted. The New England farmer will, hereafter, generally, as is done in many cases now, grow the larger and more tender varieties of Southern maize for his silo. They would not ripen in the North, but this is of no importance, as they are cut green for silo storage. But it is an error to suppose that maize is the only article stored; green oats, clover, trifolium, grass, all kinds of leguminous plants, sorghum, dourra, prickly comfrey, and even apples, are stored in silos. I mention this, because some persons, who have written confidently on the subject, have informed the public that little besides maize is used for the purpose. I have seen silos in which all sorts are packed away, separately and together. On one farm, a silo, I was informed, was stored with cow peas, another with trifolium, and so on. Perhaps one of the most important uses of the silo is to store aftermath, or rowans, which is nearly always a wasted crop in America, and I suspect is in England.

It is unimportant to the present paper to communicate particularly what is the cost of cutting, carrying, and filling the silo. The accounts vary, and the cost of American labour is not always easy to arrive at, since it is so general a custom to allow labourers rations. But, generally, the charge is not a half or a third of that incurred in making, carrying, and storing hay. Hay, in the United States, is almost always barned, though I have seen wretched little stacks on the lower grounds, piled up round a pole or small tree, and left in the open, to become absolutely worthless as forage, and worth very little as litter. Far more important to the American farmer is the comparatively small space which is taken up by ensilage, as contrasted with that needed for hay, and the absolute immunity from fire. "If I made my ensilage into hay," said a farmer to me, "even in the best of weather, I should need a double number of hands to make and store it, and when I had got it, I should not know where to put it."

The testimony is universal and overwhelming, as to the eagerness with which all animals devour ensilage, the condition in which it keeps them, and the increase of their produce. Kept under cover, cattle are far safer from the dreaded risk of plague, and sheep from the risks of rot, and the hardships of the lambing time. I have heard and read that while dry food, in lambing time, was dangerous to all ewes, and formidable to a certain per-centage, the use of ensilage was followed by uniformly good results to ewe and lamb. The only direction in which there is conflicting testimony is that of the use of ensilage for horses. Some few persons attribute dangerous and even fatal results to its employment for these animals, though many more allege that it is innocuous and beneficial. It is also said to be exceedingly valuable as food for poultry.

There is always, as far as I have seen it, some fermentation in ensilage. The smell of the product is decidedly vinous and acid. The

American chemists who have reported on the chemical character of the product say that you cannot get alcohol from it. I conclude that the smell of this substance is something which simulates it, and that the acid is lactic. I have said already that it loses about 5 per cent. of the water contained in fresh forage; but it is alleged that the amount of sugar or glucose is increased at the expense of starch and cellulose, and that the nitrogenous element is increased also, beyond the amount of concentration implied by the diminution of water. It seems to me difficult to maintain this view. It is certain that cattle eat it with avidity, and an eminent agricultural chemist of Tennessee says that ensilage, when slightly fermented, almost exactly resembles fresh forage when it has been a short time in the stomach of ruminants, and is, therefore, more readily assimilated than raw forage would be. So advantageous does this slight and almost inevitable fermentation seem to some stock-breeders, that they lay out the ensilage for twelve hours or more, in order that some slight further action may be set up in it. It is also important to note that the use of it nearly, or almost nearly, supersedes the necessity of giving store cattle water in the winter, a matter of importance in America during the winter, if not, indeed, everywhere.

Salt is not used to sprinkle the ensilage in packing, nor is chaff mixed with it. The former is superfluous, the latter dangerous, as it encourages or retains oxygen. Nor is it now the practice to spread a layer of hay or straw on the top of the forage. To do so is again to invite fermentation or mustiness. There is probably some slight layer of carbonic acid gas on the surface of the forage, and this, of course, acts as a corrective to fermentation. But though I inquired, I never heard that it was evolved in such quantities as to make the opening of a silo from the top dangerous. There is a certain amount of warmth generally developed, and occasionally it is said to amount to 90° Fahrenheit. This is supposed, in the cold winter of America, to be an advantage, as it is retained in the ensilage by the walls. It is almost superfluous to say that a properly packed and weighted silo never develops any such dangerous heat as occurs frequently in ricks. A great recommendation of the system is its safety.

Opinions differ as to the wisdom of cutting or shredding the maize, or of packing it whole. The majority adopt the former plan, but some assert that it keeps better if put in whole. The question is not so much discussed with regard to ordinary grasses. But the "giant cutters" easily manipulate a hundred tons in a day, and such a quantity may be readily packed, boarded, and weighted in the same space of time. All aver that the silo should not be uncovered for three months, and that, if it be of proper dimensions, it is most conveniently consumed from the top. There seems to be no limit to the time during which properly stored ensilage may be preserved. It should, however, be packed as closely as possible, and well trodden down, so that it may settle evenly in the pit.

The storage of ensilage may be done in all weathers. It would probably be inexpedient to fill a silo during one of these drenching storms which occasionally sweep over the Eastern States. To say nothing of the discontent of labourers, and the injury to cattle, it is possible to store ensilage in too wet a condition, and by pressure to put the walls of the silo to a strain which is needlessly severe. But the farmer need not be deterred by slight showers. If the weather is over dry, it is even expedient to water the forage as it is put in, and some farmers moisten it plentifully under such circumstances. Even if fluid collects at the bottom, it is not to be regretted. M. Goffart, who calls such a fluid "vegetable soup," strongly recommends that it should be given to animals, and by no means be thrown away. The use of a silo secures the farmer from the caprice of the weather, gives him what is practically identical forage all the year through, serves him with an agricultural saveall, enables him to increase his stock four-fold, and to fertilise his land indefinitely, and all this at greatly diminished cost.

The pioneers of American ensilage were ridiculed by the old-fashioned, and denounced by the scientific. In the history of economic civilisation, the two most active enemies of progress, if you will believe a student of these matters, have always been ignorance and science, both being apt, for different reasons, to be eminently conservative forces. Against the dogmatism of these powers, the American farmer appeals to experience. "One of you gentlemen," he says, "has told me that I am merely making a muck-heap, which will certainly ferment and rot, possibly fire." He has the best of the argument when he shows that, at the end of three or six months, when his neighbour's cow is munching hay at £4 a ton, with six quarts of oats daily, he is feeding his cattle on ensilage, which costs him 8s. a

ton, at most, and two quarts of oats, while his cow is thriving, and giving in winter a summer yield of milk and butter. He prudently avoids a contest with the scientific expert. He knows that he will be assailed with learned formularies, the sufficiency of which he doubts, but the answer to which he cannot be expected to possess. In time he gets his advocates among scientific people also, and is always certain to stifle the controversy by success. Such, at least, is the view taken by many of those with whom I have conversed on the subject of ensilage. A child can see the difference between the produce of a cow in the summer and winter, when the animal is fed on dry food in the latter season. A chemist may tell him that the difference between hay and green forage is so much water, and may talk learnedly to him about the salts, &c., contained in the materials. He may be amazed at the learning, but he is convinced by the facts.

I have given, without technical details, what have been my general experiences on the subject of American ensilage, and a summary of what I have observed and noted. There still remains another subject, on which I venture with great hesitation, and can only discuss in a tentative and doubtful fashion. That ensilage in America will be a marked success, I have no doubt. That if it be adopted generally there—as it surely will be—it will induce a further competition in English markets, which will tend to lower profits and rent in England, I cannot doubt, unless we can adapt it to our uses, and appropriate its advantages. I venture at least on saying, that it is not by denouncing and ridiculing the practice, stating what is entirely inaccurate about its results and its process, and suggesting that it should be rejected without trial, that one proves one's practical wisdom. But can it be adopted with advantage in England, or, rather, in the United Kingdom? It was with a view of aiding the solution of this question, that I asked the Government, during the October session, whether they would direct full inquiries into the practice of ensilage in the United States and on the Continent, and got an affirmative answer.

Having the happiness to enjoy the friendship of many landowners and practical agriculturists on both sides of the House, and having talked to many of them on the subject, I have generally been told that there are two practical reasons why ensilage is not so suitable, or not so great a boon, to the English as it is to the American farmer. One is that we cannot grow Indian corn, the other, that we do grow roots in abundance. Now the answer to the first of these objections is, that we can, I believe, grow Indian corn, up to the point in which it is best for ensilage, over the greater part of Southern England. A friend of mine in Oxfordshire told me that he grew Indian corn successfully as forage, and, if my memory serves me right, to the amount of twenty tons an acre. But Indian corn, though the most obvious, is by no means the only ensilage. The grain-giving grasses, grass and clover, and the leguminous plants, make excellent ensilage, the last-named probably the best of all. The caprice of the weather in England—"You have no weather in England," said an American to me, "only samples"—inflicts annually upon the English farmer incredible losses. Against these contingencies, a silo in England, as in the United States, is a save-all. Along the west coast of England and Scotland, good hay can seldom be made, in some cases cannot be made at all. But the grass can always be kept in a silo, and be kept in sound condition. Early snow in Scotland is a serious concern to the Scotch farmer. It often buries his roots, and drives him to consume his stock of hay, or use costly food. Thousands of sheep die annually in Scotland from the process of hardening. A silo would save them, and at little cost. I believe that the Highland Society is actively taking up the question of ensilage, and discussing its fitness for the northern kingdom, and I had the opportunity of supplying that society with such literature on the subject which I had collected in America.

I know no more gloomy sight than a number of store cattle munching straw or spoiled hay in an open yard during winter. They look pinched and starved, dull and spiritless, with staring coats, drooping quarters, and a general aspect of anguish. I have often calculated how long it would be before they came into condition, and how much the farmer would lose before that result arrived. An American would tell you that he could not only keep them in condition, but improve them in weight and flesh, by a ration of ensilage, which would cost no more than twopence a day for each head, and maintain eight sheep at the same charge. Whether ensilage can be grown and packed as cheaply in England as it is in America, I do not pretend to say.

For reasons of climate, economy, and safety, cattle in America, except young calves, who are allowed to roam in the forest during spring,

if the farmer has forest, are stall-fed. This practice reduces the risk of infection to a minimum—I noticed that the railway companies are rather careless in the freighting of cattle—and collects the maximum of manure. For analogous reasons, sheep are fed in enclosures, and I was assured that in Eastern America, sheep rot was almost unknown, though I admit that, hitherto, sheep breeding is not a common form of agricultural enterprise in the New England and Middle States. But what they do seem to effect is the maximum of produce, and the minimum of risk.

I cannot but think that ensilage will be of infinite value on the heavy clays, the cultivation of which has latterly been so disastrous to the farmer, and for reasons which, imperfectly imagined by me, will be no doubt clearer to those whose experience has been so unfortunate of late years. For if the land can be got into cultivation, and the produce can be carted off, it can all go into silo, which is said even to sweeten weeds and make them palatable. But I have already taken up the time of my audience to a great length, and while I can state that I have brought forward my experiences in the very reverse of an exaggerated statement, I cannot pretend to affirm that what is true of America will be true of the United Kingdom. This, however, I can say, that I yield to no one in my wish to see agriculture prosper in this country, for I know from the study of a life that its prosperity is the touchstone of national progress and diffused comfort; and it is fortunate that while there are, and will be, among honest men grave differences as to the questions connected with land, its ownership, its occupancy, and the process by which the labour on the soil should be related to both ownership and occupancy, there is no difference in the desire that Brirish agriculture should regain its former pre-eminence and sufficiency. It is fortunate, too, that the agriculturist works in the light, that he has no secret beyond his personal skill; and it may be said to his honour that, if he does desire a full price for the produce of his labour, he can make, nay, openly declines to make, any mystery about the means by which at best he can but make a modest profit, while the success of his skill and labour, sometimes his genius, is an undoubted benefit to his country and to civilisation at large. But as my Boston friend says of ensilage, "Those farmers who do not adopt improvements must take a back seat."

DISCUSSION.

The SECRETARY read the following letter from Mr. Gibbs:—

Gillwell-park, Chingford, Essex, N.E.,
January 29, 1883.

MY DEAR SIR,—If my uncertain health should deprive me of the pleasure of attending the meeting, will you kindly say for me that I have now obtained three carefully worked-out estimates for two silos like those of Mr. Mills, and they range from £309 to £500 and £688. These are for the pits only, not with roof or covers, &c. The first is in soil most favourable for construction, where there is no risk of influx of water, and where there is an ample supply of stone, gravel, and sand for concrete; this estimate is by a resident manager, and therefore exempt from all contractor's profit. I shall be happy to send a copy of the details to any one who is interested. The second estimate is given me by a firm of large contractors who have had long and varied experiences in all kinds of excavating, and concrete structures, such as tanks, public baths, wells, &c. This £500 would not cover the contingency of digging down to water. The third is from a local contractor, and includes carting up gravel, &c., from a distance of four or five miles. I hope these estimates will induce other gentlemen at the meeting to state what their silos have cost, or what estimates they may have obtained in other counties, because this is, beyond all question, a very important part of a very important subject, and a full comparison of notes thereupon will be of great value. I hope most sincerely that this process will be tried skilfully, widely, and in all possible ways this season; because if this is sufficient to save our harvests from destruction in bad weather, I shall not feel called upon to spend any more thousands in demonstrating to the country that they can be saved in another way—unless practical experience shows that to store them in silos involves a very much heavier first cost than the harvest-saver.—Yours very faithfully, WM. A. GIBBS.

H. T. Wood, Esq.

The CHAIRMAN said he had that morning received a letter from Mr. Woods, agent to Lord Walsingham, saying he had had great success with this process. He could not claim any experience himself, but he had seen some samples brought to Smithfield Show, the only objection to which seemed to be that they were somewhat deficient in smell. He would, therefore, suggest to any who were able to try experiments with it, that the addition of a little Bokhara clover might remedy this defect; for this clover, though it had not a very sweet smell in the green state, became very odorous when dry, its scent resembling the *anthox anthum odoratum*, which gave its pleasant smell to new hay.

Dr. VOELCKER said the paper would, no doubt, lead to experiments with this process, which he quite agreed was very valuable for Americans, also in France, and in parts of Germany, where it had

been in practice for a considerable time. He had lately analysed various kinds of ensilage—clover and rye, and, quite recently, some ensilaged maize stalks from Canada. It was this last which was always meant by ensilage in America, some qualifying term being used if any other material were referred to. He had with him a sample of maize stalks which was put into the silo last October, taken out the middle of last month, and sent to him direct from Canada. It was perfectly sound, though it had a peculiar flavour, by no means unpleasant. It smelt strongly of acid, and the acid was principally acetic and butyric; there was no alcohol present, because the sugar which had given rise to these organic changes, had entirely disappeared, This production of acid was an essential element in the process; if sufficient acid were not produced, it would not keep, but turn mouldy like any other food put into a pickle jar with insufficient or poor vinegar. In this Canadian ensilage he had found as much as $1\frac{1}{4}$ per cent. acid, about $\frac{1}{8}$ per cent. being lactic. The proportion of water varied considerably; in the maize from Canada it was $85\frac{1}{2}$ per cent., and no doubt if other food not so rich in sugar, and containing much moisture, were put into a silo, it would spoil altogether. Hence it was recommended by M. Goffart that a certain proportion of cut straw should be mixed with the green food. In ensilaged clover he only found 79 per cent. of water, and in rye-ensilage as little as $72\frac{1}{2}$ per cent. This showed that no certain rule could be laid down that the produce must contain such and such a quantity of water, for it depended on what the other constituents were. The more sugar there was present the less need to put anything with it, but if it were poor in sugar, some dry food must be added if you wished to preserve it. Disregard of these conditions had sometimes led to failure. He was sorry to seem in any way to oppose this method, but the circumstances of England were different from those of America. This was the only way of preserving maize stalks; you could not make them into hay economically, but in the form of ensilage they formed a very valuable food, especially for milch cows. They all knew how valuable acid food was for this purpose; every dairy farmer availed himself of brewers' grains when he could get them, but he did not feed his cows entirely upon them, because he knew that by so doing the milk would become watery and the cows poor; he gave them with the grains some cake, or Indian corn, or pea meal; and it appeared that the American farmers also gave some dry food. He had never known of cattle being kept profitably on green food alone. However valuable ensilaged maize and other green food might be to Americans, he questioned whether it was of the same importance to the English farmer; nay, he questioned whether, in average seasons, the expense of erecting silos and the occasional use which he could make of them, food preserved in this way would be as remunerative as in America. He could not subscribe to the doctrine that green food put into silos underwent no change, nor did it seem possible that the albuminous matters should increase without the destruction of some part of the substance itself, because it must come from something; and, unfortunately, neither white of egg nor any other flesh-forming substance could be produced artificially. If the albuminous matter in the ensilaged food increased, it could only be in a similar manner to that in which the ammonia salts in rotten dung increased in proportion to the amount in fresh manure. One ton of fresh manure became enormously reduced in bulk in becoming rotten, but at the same time the proportion of ammonia increased, simply because other substances in the shape of gaseous products went away into the air. With regard to the fermentation, he was quite agreed that the quantity of carbonic acid which went away was not perceptible to an ordinary observer; but at the same time if it were true that the albuminous matter increased, and also the mineral matter, as appeared in most of the analyses, it was pretty clear that something in an invisible form went away; probably more or less of the material itself was dissipated in the form of gaseous product during the process of acid fermentation. This would not be altogether a disadvantage, if it could be shown, as perhaps it might, that the amount of digestible matter increased. The woody fibre in green food, especially when over ripe, certainly became more digestible in the ensilaged mass. This would be a great advantage in the use of the food, and probably explained the success which had attended its use. The loss of substance would be counterbalanced by the greater digestibility of the food. This pointed to the propriety of instituting experiments with the view of thoroughly explaining the changes which the green food underwent. If green food could be preserved, at all seasons, in a fickle climate like the English, it would be an immense advantage to the farmer. He had some photographs representing the silos on the estate of the Count Arthur de Cheyellet, at Bouillaume, Oise, of a most elaborate construction, and he must say he did not see how such silos could ever pay. A silo need not be such an expensive affair, and if experiments were to be made, it was important that the expense of the erection should be kept as low as possible.

Mr. James Duncan said he had had some experience in this matter, having for some time had a beet-sugar factory at Lavenham, where the refuse of the beet was put into silos in the usual way. All he did was to dig a pit in the ground, slope up the sides, fill it up with pulp, which was rammed down, and cover it over with earth; the soil, he should say, was a stiff clay. At first the farmers did not take the pulp very freely, and it accumulated on his hands, but after some experience, they found it so good a feeding stuff, that they were glad to give 12s. a ton for it, even after it had been in the ground for three years. He was well acquainted with the practice of ensilage in Germany, as practised by the sugar manufacturers, and one of his friends there put in 30,000 tons of

pulp in the season, so that the silo was of immense size. There was no roof over it, and three or four inches of the stuff at the top got quite black, but still the cattle would eat it readily. Sauerkraut was only ensilage, and if that was food for human beings, surely maize, corn, or hay, treated in the same way, must be good for cattle. Dr. Voelcker said maize could not be made into hay, but it was largely done in Canada. He had seen a large quantity on the farm of the Hon. George Brown, in Toronto, in 1876, and he told him that he got seventy-five tons to the acre. He had grown maize in England, but it would only succeed when there was a very warm summer; as a rule, it was nonsense to try it. The main point about ensilage was its digestibility, and he believed that cotton cake and other foods mixed with the ensilage fodder, when the silo was filled up, would be acted upon by the acid, and become much more soluble as food. He had a large sheep farm in the west of Scotland, and was much interested in the question of preserving hay and corn there; he had erected a kiln and tried to preserve the hay in that way, but in about two years out of five, it was almost entirely spoiled, a deal of the grass which grew there was so hard that even if made into hay it was very little use, but he believed that if mixed with grains, or ensilage, it would be made digestible.

Mr. EDMUND GIBSON had had practical experience of ensilaged rye, containing about 72 per cent. of water. The cost of his silos was exactly £150, there being five of them, and their capacity was equal to about twenty acres of rye. They were entirely of concrete, and had a flat roof, but this, he believed, was a mistake, which he intended to rectify by having a roof similar to a cucumber frame. With a flat roof it was impossible to fill the silo to its full capacity. The rye was cut about the end of May, when just coming into flower, and was carried direct to the silo. It was opened in September, and in consequence of there being no pressure on the top, nine inches were found to be decayed and mouldy, but the remainder was perfectly good. He was feeding about 40 head of cattle upon it; they had about 1½ bushel of ensilage, the same quantity of swedes, some chaff, a small quantity of hay, and 2 lbs. of cotton cake, which he believed he might dispense with. He did not notice any great difference in the quantity of milk to that produced when the cows were fed on roots, but the healthy condition of the cattle was very apparent, and he intended to follow up the plan more fully another year. The great difficulty with farmers on heavy lands was the expense of carting their roots, which had to be done at a time when frequently they could hardly get on the land at all, and this it was which mainly led him to try this plan.

Mr. GEORGE FRY said he had grown a little maize this year on the headlands of his farm; he dug a hole in a dry place, chopped the maize and put it in, covered it over with planks, and threw sand on the top of it. He kept it there three months, and it was perfectly preserved. He had been astonished at Dr. Voelcker's analysis of the Canadian maize, and thought it would have been different had he analysed it fresh. He believed the quantity of acetic acid would not have been so great had fresh ensilage been analysed.

Dr. VOELCKER did not think the proportion of acid would be increased by keeping; besides, he considered it a useful feature. In ensilaged rye he only found 79 to 80 per cent. of water; but it would depend very much on the conditions of the green rye. If there were more sugar, greater maturity in the plant, there would be more acid formed; if the maize were not so mature, not so sweet, there would be less acetic acid formed. He also had grown maize in England, and also sorghum, but the crop depended very much on the season; one year it was a beautiful plant, 7 feet high; and next it was only about 3 feet, and cattle would not look at it. Two years ago he grew maize on the experimental farm, but it came to nothing; it was too uncertain a crop for this climate.

Mr. FRY, in answer to the Chairman, said his farm was in Surrey. His maize grew very well last year, although it was only about three feet high. He did not expect it to grow as it did in America.

Mr. AINSLIE suggested that some good hay might be put in with the ensilage, which would probably help to preserve it.

Mr. PHILLIPS thought the question of ensilage depended very much on having a large crop to the acre. They grew twenty to thirty tons to the acre in America, but he questioned the advisability of putting good English grass into a silo, especially when they heard that acid was produced at the cost of sugar, for he believed sugar would be better feeding stuff of the two. He had intended building a silo last year, but on thinking the matter over, thought it better to see if he could not produce something which would smell sweet instead of sour. He had, therefore, spent some time in endeavouring to make grass into cake, and he had some samples made in 1879, 1880, and 1881, which smelt as sweet now as a newly-mown field. There were difficulties in the way, but he hoped to overcome them. Mr. Gibson had given the cost of his silos, which held twenty acres of rye, at £150, which was a serious item, and he doubted whether twenty acres of good hay would not be worth more than the ensilage. The fan question was much discussed, and he, with others, had been much disappointed in trying to make green grass into hay. Last week he cut into six ricks; one, which had been made with grass hauled in in a shower, was one mass of mould; another one was not much better; but another, which was made of old meadow grass put into rick at least two days sooner than it could have been without the fan, was very good hay. No doubt a fan was of very great use in this way, by enabling the farmer to save a day or two in doubtful weather; but as to putting it up damp or wet, it was altogether useless.

Mr. DARBY remarked that he calculated that Mr. Gibson had about 150 tons of rye in his silos, which, at 5 per cent., was only 1s. a ton., and he should like to know if it could be preserved in any other way cheaper. He should like to ask Dr. Voelcker about Mr. Gibson's rye, which he believed he had analysed and declared to be equal to green rye.

Mr. PEARCE asked if he understood Dr. Voelcker aright, that the whole of the sugar in these substances was dissipated or destroyed. He thought he had seen analyses, in which the quantity of sugar was stated, especially of glucose.

Dr. VOELCKER said the ensilaged rye, as he had mentioned, contained about 72½ per cent. of moisture; he did not know what it contained in its original state, but it was quite possible it might even get better, and yet lose something. If he knew what quantity was put in to begin with, he could tell what was lost. You might put in a certain quantity, some of which would disappear, and what you took out might be better in quality. He had compared it with the average quality of green rye, and found it just as useful. With regard to the sugar, he did not conceive it possible that a material, which had passed through alcoholic fermentation, and subsequently, acetic fermentation, should retain any glucose, which was very liable to undergo change. There was probably about as little sugar in ensilage as in sour beer.

Mr. PEARCE asked if the sugar really underwent the alcoholic fermentation in this process; because it seemed to him the conditions necessary to alcoholic fermentation, heat and the presence of air, were absent.

Dr. VOELCKER said the presence of acetic acid was not conceivable without a previous alcoholic fermentation. In a certain stage you could absolutely smell the alcohol. The temperature was quite as high as was necessary.

Mr. FRY said he had never heard that there was alcohol in the silo, though ensilage might undergo alcoholic fermentation after it was taken out.

Mr. DRUCE said this question was being very much discussed by agriculturists, and was about to be considered by the Farmers' Club, of which he was secretary. He must protest against the notion that English farmers went on in a humdrum way, and did not take advantage of scientific improvements. Nowhere had such improvements in farming, such agricultural implements, and such specimens of stock been seen as in England, and nowhere else, he believed, was so much produced per acre. At the same time, the farmer was bound to be cautious, and not go rashly into heavy expenses until he was sure it would pay. When they heard that £150 was required to prepare a silo for 20 acres, he would remind them that that was a large sum to most farmers; and he thought the cost must be much reduced before this plan could be generally adopted. But it had been tried some time ago, and if Prof. Thorold Rogers had ridden over from Oxford to his father's farm 8 or 9 years ago, he could have seen ensilage in operation. In that case it was not successful, probably from the silo not being rendered water-tight. Reference was made in the paper to two main reasons why this method was not likely to be adopted in England, and with regard to growing maize, he might say that his father had tried it with the same result as Dr. Voelcker had referred to. The other point, that in England we had abundance of roots, seemed to him very important. More roots were grown here than elsewhere, and hence ensilage was not so much required. Ensilage was not a dry food, and cattle required both dry and moist food. Where it would be of considerable service, no doubt, was on dairy farms; and he noticed that dairy stock was principally alluded to in the paper, and the milk-producing powers of ensilage. As an Assistant Commissioner to the Royal Agricultural Commission, he had travelled over most of the eastern counties, and he was thoroughly convinced that anything which would enable the farmers on those heavy clay lands to produce more milk and butter, would be of immense advantage both to them and to the country at large. The only farmer he met who had not lost money was one in Essex, who sent milk to London.

Prof. THOROLD ROGERS, in reply, said his object had been not to advise farmers, and still less to enter into controversy with scientific experts, but simply to give an accurate account of what he had seen in America. He saw there a successful experiment—not one instance of failure having come under his notice—which seemed to him minatory to English interests, unless we could meet it in some way. He could not help thinking that what was true of Northern Germany, and of northern parts of France, ought to be true of England in some degree, although the climate must be more unfavourable. He knew very well, having studied the state of agriculture all over western Europe, that we did grow far more produce per acre than almost any European country, possessing on the whole, he believed, a better soil, but it occurred to him that the peculiar feature of the silo system was that it rendered the farmer independent of the weather. He had never come across any ensilage in America which was so strongly acid in smell as that shown by Dr. Voelcker. It was generally rather vinous, and he had asked whether alcohol could be produced from it, and was told that an eminent agricultural chemist stated he could only procure it in a very minute quantity. He was as much in the dark as Dr. Voelcker as to how the nutritious matter could be increased, but the analysis of the French chemist showed that the nitrogenous matter was increased, and it was asserted in more than one analysis made in America that such was the case. He could only express his astonishment at the cost of silos as given in the *Times* and in the letter of Mr. Gibbs, for the

charge seemed to him monstrous. Mr. Gibson had given them the actual cost of his silos, which was about £1 per ton capacity, and this was precisely the maximum price given in Commissioner Loring's report of a silo built in the most expensive manner, and roofed in, in the United States. On the other hand, there were many built in a much cheaper fashion, but giving the same uniform result, at a cost of not more than 50 cents., or about 2s. per ton capacity. No doubt, in experimental estimates, it was natural that somewhat exaggerated figures should be given. One member of the House of Commons with whom he had conversed on the subject, said he intended to construct on his farm in South Hampshire a large number of silos of a circular shape in the chalk hills, lined with brick, which he believed would be the cheapest form. At the same time there were earth silos which were perfectly successful. The only thing he could not understand was, that some gentlemen who had tried the experiment did not weight the silo, which was absolutely necessary to keep the stuff in good condition.. Sir Thomas Acland told him he had experimented by mixing chopped clover and chopped straw, and filling up a barn with it, the side being built up; he put no weight upon it, and as he told him, he had only built a mixen, not a silo. The essence of a silo was that it should be fully weighted; and, generally speaking, in the United States the weight was from 500 to 1,000 lbs. per square yard. A very common method was to use empty cement barrels filled with sand. It occurred to him that a mixture of rye, grain, and vetches would form capital ensilage, taking the vetches in the state of milk. The authorities at the Croydon Sewage Farm told him they intended to build a silo, and he might say that although ensilage could not be kept for any length of time, it was freely sold in the American markets at 16s. a ton, the cost being about 8s. He was quite alive to the necessity of giving milch cows some nitrogenous food; and talking to the manager of the Croydon Sewage Farm, he was informed that their cows always got out of health in about two years. He asked if they gave them anything but grass, and was told not; when he told him just what Dr. Voelcker had said, that if they gave them some solid food in addition, they would be all right. This was a subject which required careful consideration. The differences of climate, and of the character of English agriculture, did not make the adoption of the American expedient so urgent as it would be were the circumstances the same; but he was certain that, for want of means of saving crops, thousands of acres of good grass and other produce were either lost or spoiled. Whatever must be the difference of climate, the silo was emphatically a save-all; it rendered the farmer independent of the weather, and secured him the ability to keep his produce in as nearly as possible the condition in which it was when cut. With regard to store cattle, he could not help thinking that enormous loss must fall on those who were obliged to let their stock get into such a bad condition, as was sometimes seen, as it must take a long time to get them into good condition again.

The CHAIRMAN then proposed a vote of thanks to Professor Thorold Rogers for his paper, which was carried unanimously, and the proceedings terminated.

Miscellaneous.

SILK-PRODUCING BOMBYCES REARED IN 1882.

By ALFRED WAILLY

(Membre-Lauréat de la Société d'Acclimatation de France)

(Continued from p. 215.*)*

Ova of my new hybrid, this year, as last, have been sent to correspondents in Europe and America, but as yet, with a few exceptions, I have not heard of the results obtained.

At the Société d'Acclimatation's offices, in Paris, Mr. Huin, considering the difficulties in his way, reared the larvæ of the hybrid with the most satisfactory result, and obtained a good number of cocoons; the larvæ were reared on cut oak branches. But the rearing having taken place early, some of the moths emerged in the autumn. Mr. Huin, in a letter received on 15th of November, says:—"Many of the hybrid larvæ were destroyed by mice, which swarmed in the offices. He did not know why so many larvæ disappeared, till he caught one *in flagrante delicto*." Mr. Huin also mentions the fact that many of the ova, although they were fertile, did not hatch. Now this is due to the ova being detached from their point of support. The eggs have to be detached from the sides of the cages in which they have been laid. If the ova were glued to a piece of cardboard, or something else, many larvæ, which on hatching drag the shell of the egg (especially if the eggs are on a smooth surface, and are thus unable to come out), would come out of the egg without any difficulty. Some larvæ can only just cut out the shell of the egg, and die inside it; others turn round in the shell, and try to come out tail first, in which case they are always unsuccessful, unless assistance is given to them, but it is very delicate and dangerous operation, that of cutting the shell of the egg to free the larva.

Mr. Huin says that the larvæ of the hybrid were larger than those of *Pernyi*, and remarkably strong, and easy rear on cut branches. He has taken copious notes on the rearing of my hybrid, and his report will appear in the *Bulletin de la Société d'Acclimatation*.

The moths of the hybrid emerged from the 23rd of April to the 5th of June. From my notes I find that fifteen females and twelve males emerged. The cocoons, excepting a few of mine, were from

larvæ, bred in Germany, Austria, Scotland, and North America. Only two cocoons were sent me from America, one of which died; the other produced a small male. All the other cocoons were of very large size. Eleven pairings of the hybrid were obtained, which is a most remarkable success, considering that male and female moths do not always emerge simultaneously, and that a few were preserved as specimens.

Although it may not be very interesting reading, I will reproduce the notes, such as I have them in my book.

April 23rd, one female taken to the British Museum, with specimens of *Pernyi* and *Roylei*; on the 26th, one female; in the afternoon of the 28th of April, one male from American cocoon; this paired in the evening with a female *Pernyi*; on the 3rd of May, two females emerged; on the 4th of May, one male and one female emerged, which paired after one o'clock in the morning of the 6th of May. The female laid 266 eggs. On the 6th of May, one female; on the 7th, one female, and on the 8th, one male. The second pairing took place on the evening of the 9th of May. On the 10th of May, in the afternoon before four o'clock, three female hybrid moths emerged; on the 11th, before one o'clock in the afternoon, one male hybrid emerged. The third pairing took place on the 10th, with the male which had already paired on the evening of the 9th; the pairing lasted from the evening of the 10th, till half-past eight o'clock on the 11th of May. On the 11th, fourth pairing with a female emerged on the 10th, and the male emerged in the afternoon of the same day, the 11th. In the evening of the 11th, before eight o'clock, one male hybrid emerged, which paired later on the same evening, this being the fifth pairing. On the 13th of May, one female emerged before four o'clock in the evening; on the 14th another female emerged at about two o'clock in the afternoon. On the 14th, at nine o'clock in the evening, a pairing took place between the female hybrid, born on the 13th, and a small male which had emerged from one of two cocoons sent to me from Paris, as being the hybrid, but these cocoons were so similar to those of *Pernyi*, that I thought a mistake had been made with respect to them, and therefore I did not count them as being cocoons of the hybrid. On the 15th, the same male, sent as a hybrid, paired with the female hybrid born on the 14th; this was the second pairing of the male.

On the 16th of May, one male hybrid emerged, which paired the same day, in the evening, with the female hybrid which had already paired with the small above-mentioned male, the pairing of which evidently had not taken effect. This pairing of the 16th of May was the sixth. On the 18th of May, about seven o'clock in the evening, one male hybrid emerged, and on the evening of the 19th another male emerged; one of these two males was killed for a specimen, the other paired with a female *Pernyi*. The produce of this must have been ¾ *Pernyi* and ¼ *Roylei*. On the 21st, in the evening, the same hybrid male again paired with a *Pernyi* female. On the 22nd of May, two female hybrid moths emerged, one of which paired the same day, in the evening, with the male hybrid which had already paired twice with *Pernyi* female. N.B.—"This pairing I omitted to count, and it would bring the number of pairings of the true hybrid to twelve instead of eleven."

On the 23rd, one male hybrid moth emerged, which paired the same day, in the evening, with the second female, born on the 22nd of May. This is counted as the seventh pairing instead of the eighth by mistake.

On the 24th of May, one male and one female hybrid moths emerged, which paired on the same day, this being marked the eighth pairing. Here my notes are incomplete respecting the births of moths, as I find the ninth and tenth pairings taking place on the same day, and another marked the eleventh on the 25th of May, the male having paired for the second time. On the 26th of May, the male hybrid, which had paired already twice, paired a third time with a female *Mylitta* of the Ceylon race, but as I mentioned before, the ova did not hatch.

On the 29th of May, one male hybrid moth emerged, and on the 5th of June another male, which was the last of the moths.

The ova obtained from the pairing which took place on the 6th of May, began to hatch on the 31st of May, and on the 5th of June ova of other broods hatched.

Owing to the terrible weather we had during June and a part of July, the larvæ totally unprotected on such small trees as I have in my garden, the larva state was of an extraordinary length, and it was only on the 27th of August that I obtained the first cocoon; the second was obtained on the 26th, the others in the course of September.

The following is the letter Mr. F. Moore, of the Bethnal-green Museum, kindly sent me, to which is added his description of the moths (male and female) of my hybrid *Roylei-Pernyi*. The letter is dated December 13th, 1882:—

"Dear Sir,—Enclosed is a description of the imagos of your hybrid *Roylei-Pernyi*, which I promised to send you. I was much interested on my visit to you in August, and was astonished to see with what facility the larvæ of the various silk-producers can be reared in the open air. Your larvæ of *Cecropia*, *Luna*, *Selene*, *Roylei*, and the hybrid *Roylei-Pernyi*, all appeared in a most healthy condition. They could not have been better had they been living on the trees in their native country.—Yours truly, F. MOORE."

Description of the hybrid Roylei-Pernyi.—The imago, in point of colouration, is intermediate between the two species. Both sexes of the hybrid show the mealy-olivaceous colour of the pure *Roylei*, dominated by a tinge of the ochraceous colour of the *Pernyi*; the ochraceous tinge, however, is brightest across the

discal area of both wings within the transverse band, and more especially so is the female. The bands on both wings are more strongly developed than in *Roylei*, and more so even than in *Pernyi*; the ocelli in both sexes are larger than in either *Roylei* or *Pernyi*, the talcose central spot being much larger than in *Roylei*, but of about the same size as in *Pernyi*. The ocellus on the hind wing differs from that of *Roylei*, in having the upper curve somewhat extended upward, thus giving it a slightly lobate form, as in some female specimens of *Pernyi*. Both sexes of the hybrid are comparatively larger than the general size of *Roylei*, and are much larger than *Pernyi*.

(To be continued.)

FOREST FIRES.

It appears from a paper by Professor C. S. Sargent, communicated to the Massachusetts Board of Agriculture, that when a forest is burnt in the United States, the same kind of tree that was destroyed does not spring up again. Particulars as to this fact were given in an article in the *New York Tribune*, from which the following extract is taken :—

"If a forest is destroyed by fire, which kills the trees and undergrowth of shrubs and herbs, the same species, except in the case of some of our least valuable trees, rarely spring up again. Let us take the case of a white pine forest, because the white pine is probably the most valuable forest tree in New England. If a forest of white pine is destroyed by fire, this tree does not spring up again, as it would under proper care, and the land is not covered again with any growth of trees for a considerable period. The fire-weed, *Erecthites hieracifolia*, a composite like a sow-thistle in foliage, but more closely related to groundsel in structure, first makes its appearance. The light seed of this plant is often blown a long distance, and falling on the bare ground, germinates quickly, and finally covers the burned surface with vegetation. Birds drop the seeds of raspberries and blackberries, which find sufficient nourishment and light for germination. These, as they grow, cover the ground and afford protection to the stones of the little moreton cherry *(Prunus pumila)*, dropped by birds also, or to the light seeds of the grey birch, or some of the willows or poplars, which are constantly blowing about, and will germinate anywhere upon any unshaded ground. These are generally the first trees which succeed a fire-swept pine wood; but years elapse before the ground is re-covered, even with such trees. The cherries, and the birch and poplars are short-lived, and are succeeded by more valuable broad-leaved trees. Squirrels and other animals deposit acorns in the ground, and the wind brings the seeds (fruits) of maples, ashes, and the valuable birches. Such seeds find protection among the poplars and willows which had sprung up, and as these die the more valuable trees get a chance to grow, and gradually occupy the ground. This new forest of hardwood trees, if protected from fire, will long occupy the ground; and the original pine will not appear again until the land, long enriched by an annual deposit of leaves, has been once more stripped of its tree covering and mellowed by years of cultivation. Such land nearly all over New England, if freed from the plough or scythe, and guarded from the fire and pasturage, grows up again with pine. The different processes, however, by which white pine land has been again brought into the condition to produce spontaneously another crop of pine have occupied a long period of time—so long, indeed, that it must extend through generations of human life. The forest fire, then, which destroyed the pine, destroyed as well the capacity of the land to produce a similar crop for a period of from 50 to 100 years.

THE NUMBERING OF YARN.

This subject has recently occupied the attention of the Industrial Society of Amiens, and a competition was organised for the best treatise on the numbering of all descriptions of textile yarns in the various industrial countries of the world. It was the special object of the society to obtain a trustworthy set of tables, which would facilitate, to manufacturers and others engaged in the yarn trade, the comparison of the numbers used by various nations. This idea has been carried out in the work sent in by M. Leon Gauche, of Lille, who obtained the gold medal, and whose services to the mercantile community were also recognised by the French Government by an academic decoration being awarded to him. The work is considered likely to be of service in preparing the industrial public of Europe for the complete discussion, at the next congress which takes place, of the long debated scheme for uniformity in yarn numbering.

In reporting upon M. Gauche's treatise to the society which instituted the competition, M. Roger has enumerated several leading points in connection with the general question of yarn numbering. He remarks that the numbering of yarns is based upon three positive elements; the length and the kilometric weight, as well as the absolute desiccation augmented by the legal allowance. According to the French system, the yarn is divided into small skeins of 100 metres in length, ten of these being joined together to form skeins of 1,000 metres. The quantity of these large skeins necessary to obtain a a weight of 500 grammes indicates the number. The verification of moisture by conditioning is in principle optional, but it becomes obligatory, it is stated, upon the demand of one of the interested parties. This metric system, though promulgated by edict in 1810, was not immediately adopted in France, and thus, even to the present day, there are to be found, in some important business centres in France, certain illegal systems of numbering, based on the ell, foot, or inch. The difficulty of comparison which exists as to local standards becomes

more marked, when the numbering adopted in countries which have a metric system of weight and measurement comes to be compared with the numbering of countries where this system is not in force. Thus England has a yard standard for yarns, and weighs them by the English pound of 453 grammes; while various continental nations also adhere to local standards of weight and measurement.

The principle of uniform yarn numbering was adopted at the Vienna Congress in 1873, but its application has met with the difficulties that might be expected. The tables drawn up by M. Gauche are, therefore, considered likely to be of material service to those engaged in the yarn trade for some time to come.

Correspondence.

IRON DRAIN PIPES WITH LEAD JOINTS.

Mr. B. H. Thwaite writes;—"If iron is brought into contact with lead, galvanic action is at once established, and as the lead is electro-negative to the iron, it is preserved at the expense of the latter; the electrolytic action produces, near the point of contact of the metals, tubercular corrosive action or pitting. "The writer has several examples of iron which exhibit the abnormal local oxidation mentioned, and nothing but the electrolytic action, in these instances, could have caused such an abnormal degree of pitting oxidation. "A close observation of some old iron railings, fastened in lead, will clearly exhibit this phenomenon of local oxidation. The writer has seen iron railings, which have actually corroded to a thread at the point of contact, while the upper part of the railing exhibited very little corrosive action. These railings were only subjected to the corrosive influences of the atmosphere of a town; what would, therefore, be the corrosive effect of the contact of lead and iron when subjected to the exciting solutions of ammonia and other acids contained in sewage? The writer has seen ordinary water-pipes after a few years exposure, which were a complete mass of hydrated sesquioxide, the accumulation of rust having entirely choked them. The writer would be glad to know from Mr. Burton the result of any examination of lead-jointed iron drain-pipes, which have been in use for several years. Judging from experience, the writer fancies that, if the iron pipes before being fixed have not been rendered rustless, they would be found to be almost entirely corroded away, at least, near the lead joints.

SANITARY INSPECTION OF HOUSES.

In regard to this sanitary inspection there is one great point of special interest to the public which my own experience has often brought out, viz., the danger of delay. Firstly, there is often danger in delaying inspection, and, secondly, danger in delaying rectification of faults. So far as I could judge, disease and death have arisen from both causes. In regard to the comparative merits of the peppermint and smoke tests, I think the latter is much the better. I have used the smoke test for years back with the addition of sulphur to produce smell, &c., but sometimes people have a cold, and cannot or will not smell; but the smoke filling the house and sometimes chasing the occupants out cannot be gainsayed. And, as Mr. Burton says, with the smoke test the site or sites of the faults can be localised. The inspection and testing of houses is fast becoming a blessing to the community.

W. P. BUCHAN.

21, Renfrew-street, Glasgow,
Jan. 27th, 1883.

Every word in the letter of Mr. John W. Wood, dated the 20th inst., is acceptable and true. His suggestions, together with those of Messrs. Mineard and Collins, at the meeting of the Society on Wednesday, the 17th, were propounded and formulated by the Public Health Conference in London, on June 11th, 1880, and all alike are now accepted and inculcated by "men of light and leading." Why then ever revolve in the same plane and within the same fixed limits, like a "merry-go-round" at Bartholomew Fair. It goes without saying that the required certificates must proceed from competent and incorruptible sources; that sanitary inspectors must be better men, and better paid; that the new system should be self-supporting; moreover, builders and agents would not often need pressure to produce the official certificate to intending tenants on demand, as implied in Mr. Wood's third proposition. All these points may now be taken for granted; and, as I have been myself parent or sponsor to each one of them, I pray you to let us move on but a few steps, and break new ground in our assault upon the castle of indolence.

C. N. CRESSWELL.

1, Hare-court, Temple,
Jan. 30th, 1883.

In the *Journal* of January 26th, Mr. John W. Wood suggests that there should be established, by the Local Government Board, an examination of sanitary inspectors, with a view to the issue of certificates of competency. The suggestion is a very valuable one; but it is not new. In order to establish a standard of sanitary knowledge for surveyors and inspectors of nuisances, the Sanitary Institute has held examinations since the year 1877. The Board of Examiners is a strong one, seeing that it includes the names of Professor De Chaumont, Professor Corfield, Mr. Rogers Field, Mr. Michael, Q.C., Professor Robinson, Mr. Turner, and Mr. Bartlett. There have been twelve examina-

tions held in all. Speaking from recollection, I should say that more than one-half of the candidates who have come up as local surveyors have failed; but that there have been granted certificates of competency to eighteen local surveyors, and to thirty-eight inspectors of nuisances.

It has always appeared to me that it is desirable that evidence should be afforded, that local surveyors and inspectors of nuisances possess a knowledge of sanitation before they receive their appointments, just as the fact that medical men have acquired a knowledge of their profession is evidenced by the examination they have passed; because the local surveyor is the assistant of the medical man in carrying out preventive medicine. And it is satisfactory to find that the efforts of the Sanitary Institute in this direction are being recognised by several Corporations, who have required their inspectors to hold certificates of competency from the Institute.

DOUGLAS GALTON,
Chairman of the Board of Examiners of the Sanitary Institute.

12, Chester-street, Grosvenor-place, S.W.,
January 29, 1883.

General Notes.

PATENTS IN 1882.—The number of patents applied for during the last year was 6,241, being a considerable increase upon the applications for the year 1881, which amounted to 5,751.

FRENCH TECHNICAL SCHOOLS.—To the three Ecoles d'Arts et Métiers already existing in France, at Angers, Aix, and Chalons, a fourth has lately been added at Lille. A fifth has also been decided upon at Nevers, chiefly for giving practical instruction in boiler-making, and iron roofs and bridges; and the Chamber of Commerce and the Municipal College of Saint Nazaire claim the foundation of a sixth, for training engineers for the navy. The Ecoles d'Arts et Métiers at Dellys, in Algeria, is chiefly a school of apprenticeship.

ADULTERATION OF CEMENT.—The German Union of Cement Manufacturers has decided that, leaving apart the question whether certain mixtures are useful or otherwise, any mixture must be regarded as an adulteration, unless it be so declared and marked upon the sack or barrel. The only exception made was in favour of certain substances like plaster of Paris, the addition of not more than 2 per cent. of which improves the cement. The most usual form of adulteration consists in adding the powdered slag from blast furnaces, which gives the cement a fine greenish tint, the usual sign of high burning, and of great density, thus deceiving those who judge of a cement by its weight.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

FEBRUARY 7.—"The Modern Lathe." By J. H. EVANS. T. W. BOORD, M.P., will preside.

FEBRUARY 14.—"Some Points in the Practice of the American Patent Office." By SIR FREDERICK BRAMWELL, F.R.S. R. E. WEBSTER, Q.C., will preside.

FEBRUARY 21.—"Recent Improvements in Agricultural Machinery." By D. PIDGEON. Sir FREDERICK BRAMWELL, F.R.S., will preside.

FEBRUARY 28.—

MARCH 7.—"The History of the Pianoforte." By A. J. HIPKINS. JOHN STAINER, M.A., Mus. Doc., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at 8 o'clock:—

FEBRUARY 6.—"Social Conditions and Prospects in Madagascar." By Rev. J. PEILL. Sir DONALD CURRIE, K.C.M.G., M.P., will preside.

FEBRUARY 27.—"Egypt, Present and to Come." By ROBERT W. FELKIN.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings at Eight o'clock:—

FEBRUARY 22.—"Some Causes of Fires and Methods for their Prevention." By WALTER G. McMILLAN, F.C.S. Captain SHAW, C.B., will preside.

INDIAN SECTION.

Friday evenings at Eight o'clock:—

FEBRUARY 16.—"Overland Commercial Communication between India and China, *viâ* Assam." By CHARLES H. LEPPER. Sir RUTHERFORD ALCOCK, K.C.B., will preside.

CANTOR LECTURES.

Monday evenings at Eight o'clock:—

Second Course, on "Solid and Liquid Illuminating Agents." By LEOPOLD FIELD.

LECTURE II.—FEBRUARY 5.

Primary, or unmanufactured materials:—Tallow and Lard. Bee, Myrtle, Japan, and other Waxes. Spermaceti. Palm and Cocoanut oils. Candles from the foregoing. Night-lights.

LECTURE III.—FEBRUARY 12.

Colza, Olive, Whale, Sperm, and Fish oils. Mineral oils. Lamps:—The Argand, Moderator, Duplex, and Silber methods. Flashing points. Government restrictions.

LECTURE IV.—FEBRUARY 19.

Secondary, or manufactured products. Chevreul's discoveries. Fatty acids; their formation by saponification, distillation, and pressure. Glycerine. Collateral benefits accruing from the Palm oil trade.

LECTURE V.—FEBRUARY 26.

Paraffin. History and sources. Outlines of the chief processes of manufacture. Coal-tar products. Paraffin oil. Naphtha. Petroleum.

LECTURE VI.—MARCH 5.

Ozokerit, and other mineral sources of light. Manufacture of Candles. Survey of the candle trade and the various inventions and industries excited hereby. Conclusion.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Leopold Field, "Solid and Liquid Illuminating Agents." (Lecture II.)

Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Mr. C. S. Read, "The Recommendations of the Royal Commission on Agriculture."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Society of Engineers, 6, Westminster-chambers, S.W., 7½ p.m. Inaugural Address by the President.

Society of Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. A. H. Allen, "The Chemistry and Methods of Examining Fixed Oils."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. E. C Robins, "The Special Buildings required for Applied Science and Art Instruction, and for the Development of Technical Education generally."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Rev. J. Lias, "The Unknown and Unknowable: a Reply to Herbert Spencer."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Aubrey Husband, "The Physiology of the Brain."

TUESDAY, FEB. 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Rev. J. Peill, "Social Conditions and Prospects in Madagascar."

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. C. Williamson, "Primæval Ancestors of Existing Vegetation." (Lecture IV.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on Mr. John Fernie's paper, "Mild Steel for the Fireboxes of Locomotives in the United States."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Biblical Archæology, 33, Bloomsbury-street, W.C., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. The Secretary, "Additions to the Menagerie in January." 2. Messrs. Salvin and Godman, "A New Pigeon of the Genus *Otidiphaps*." 3. Mr. Sclater, "Further Notes on *Tragelaphus gratus*." 4. Mr. E. W. White, "Supplementary Notes on the Avifauna of the Argentine Republic."

WEDNESDAY, FEB. 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. H. Evans, "The Modern Lathe."

Meteorological, 25, Great George-street, S.W., 7 p.m.

Geological, Burlington-house, W., 8 p.m. 1. Mr. Henry Hicks, "The Metamorphic and Overlying Rocks in Parts of Ross and Inverness-shires;" with Petrological Notes by Prof. T. G. Bonney. 2. Mr. E. Wethered, "The Lower Carboniferous Rocks in the Forest of Dean, as Represented in Typical Sections at Drybook." 3. Mr. E. A. Walford, "The Relation of the So-called 'Northampton Sand' of North Oxfordshire to the Clypeus Grit."

Entomological, 11, Chandos-street, W., 7 p.m.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Mr. A. W. Gerrard, "A Research on the Alkaloid Gelsemine and some of its Crystalline Salts." 2. Dr. Thresh, "Aromatic Spirit of Ammonia." 3. Messrs. W. R. Dunstan and F. W. Short, "An Apparatus for Continuous Extraction;" and "The Assay of Nux Vomica." 4. Messrs. W. R. Dunstan and F. Ransom, "The Constitution of Liquor Sodæ Chloratæ;" and "The Action of Chlorine upon Solutions of Sodium Carbonate."

East India Association, 14, Regent-street, W., 3 p.m. Mr. M. D. Dadysett, "Social Intercourse Between Europeans and Natives in India."

Archæological Association, 32, Sackville-street, W., 8 p.m. Mr. H. Syer Cuming, 1. "The Old Traders' Signs in St. Paul's Churchyard." 2. Mr. George Lambert, "Notes on Richard Cromwell."

Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m. Annual Meeting.

THURSDAY, FEB. 8...Telegraph Engineers and Electricians, 4, The Sanctuary, S.W., 8 p.m. 1. Mr. James Graves, "The Magnetic Storm of Nov. 17, 1883." 2. Mr E. O. Walker, "A Magnetic Storm in India." 3. Mr. E. O. Walker, "Earth Currents in India." 4. Mr. Alex. J. S. Adams, "Earth Currents (third paper), Sun Spots, and Electric Storms."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Prof. Robert Rerr, "The Proper Use of Modern Classical Architecture."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. W. M. Flinders Petrie, "The Arts of Ancient Egypt."

Royal Institution, Albemarle-street, W., 3 p.m. Professor Dewar, "The Spectroscope and its Applications." (Lecture IV.)

Inventors' Institute, 4, St. Martin's-pl., W.C., 8 p.m.

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Mr. H. Hart, "Note on the Sylvester-Kempe Quadruplane." 2. Mr. S. Roberts, "Curves obtained by an Extension of Maclaurin's Method of Constructing Conics." 3. Mr. J. Griffiths, "Note on a Method of Reducing a Certain Differential Expression to the Standard Form." 4. Mr. J. Hammond, "The Use of Certain Differential Operators in the Theory of Equations."

FRIDAY, FEB. 9...Royal United Service Institution, Whitehall-yard, 3 p.m. Mr. Nathaniel Barnaby, "Battle Ships."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. M. D. Conway, "Emerson, and his Views of Nature."

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, FEB. 10...Physical, Science Schools, South Kensington, S.W., 3 p.m. Annual General Meeting. Professor Silvanus Thompson, "The Graphic Representation of the Duty and Efficiency of Electric Motors."

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. Bosworth Smith, "Episodes in the Life of Lord Lawrence." (Lecture IV.) The Siege and Capture of Delhi.

Journal of the Society of Arts.

No. 1,577. Vol. XXXI.

FRIDAY, FEBRUARY 9, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Mr. Leopold Field, F.C.S., delivered the second lecture of his course on "Solid and Liquid Illuminating Agents," on Monday evening, February 5th. He commenced with a description of the old tallow candle and of the improvements made in wicks by Mr. Palmer and others, and then described the processes in use for the manufacture of wax and spermaceti candles, as well as the sources of the supply of wax and spermaceti. The lecture was illustrated by the exhibition of a large number of specimens, and the modes of making the different kinds of candles were shown.

FOREIGN & COLONIAL SECTION.

At the meeting of the Section held on Tuesday evening, February 6th, Sir Donald Currie, K.C.M.G., in the chair, a paper was read by the Rev. J. Peill on "Social Conditions and Prospects in Madagascar." A report of the meeting will appear in next week's *Journal*.

PREMIUMS FOR THE 129th SESSION.

The following prizes are offered by the Council for the year 1883:—

John Stock Prize.—A Society's Gold Medal, or £20, for the best design from a poem, or from history, or from the Scriptures, prepared with a view to Mural Decoration.

Benjamin Shaw Prize.—1. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the operations of coal-mining." 2. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the manufacture, storage, and transport of explosives."

The Council leave it to the competitors to bring the plans under their notice in any way they may think proper, whether by model, written description, or otherwise.

Howard Prize.—A prize of £100 for the best Essay on the Utilisation of Electricity for Motive Power. Preference will be given to that Essay which, besides setting forth the theory of the subject, contains records with detailed results of actual working or experiment. The Society reserves the right of publishing the prize essay.

Fothergill Prize.—A Society's Gold Medal, or £20, is now offered for the best Invention having for its object the Prevention or Extinction of Fires in Theatres, or other places of public amusement.

Mulready Prize.—A Society's Gold Medal "To that student in a School of Art in the United Kingdom who exhibits the best Drawing from the nude figure, executed in black and red chalk, in the manner so successfully practised by Mulready."

Designs, plans, models, essays, descriptions, inventions, &c., intended to compete for any of the above Prizes, must be sent in on or before the 31st October, 1883, to the Secretary of the Society of Arts, John-street, Adelphi, London.

Further particulars relating to the Prizes will be found in last week's *Journal*, or may be obtained on application to the Secretary.

OWEN JONES PRIZES FOR FURNITURE DESIGNS.

The Council are trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of the subscriptions to that fund, upon trust to expend the interest thereof in prizes to "Students of the Schools of Art, who in annual competition produced the best designs for household furniture, carpets, wall-papers and hangings, damasks, chintzes, &c., regulated by the principles laid down by Owen Jones;" the prizes to "consist of a bound copy of Owen Jones' 'Principles of Design,' a Bronze Medal, and such sums of money as the fund admits of."

The prizes will be awarded on the results of the Annual Competition of the Science and Art Department. Competing designs must be marked "In competition for the Owen Jones Prizes."

No candidate who has gained one of the above prizes can again take part in this competition.

The next award will be made in 1883, when six prizes are offered for competition, each prize to consist of a bound copy of Owen Jones' "Principles of Designs," and the ociety's Bronze Medal.

H. TRUEMAN WOOD,
Secretary.

FOREIGN AND COLONIAL SECTION.

Tuesday, January 30, 1883; Colonel L. BATEMAN-CHAMPAIN, R.E., in the chair.

The CHAIRMAN, in introducing Mr. O'Donovan, said he was the most adventurous specimen of a particularly adventurous race, which began with William Howard Russell, and would probably last as long as civilisation itself. He (the Chairman) had often heard his name, but did not become acquainted with him until the autumn of 1880, when he went out as special correspondent of the *Daily News* to join the Russian forces, who were about to retrieve the ill-success which had previously attended their movements. He (the Chairman) then visited General Scobeleff at Tchikislar, at the head-quarters of the Russian forces at the south-east of the Caspian Sea, who received him with great warmth and cordiality; but unfortunately Mr. O'Donovan had just left, some difference of opinion having, not unnaturally, arisen between him and the Russian commander as to the way in which the duties of a correspondent should be carried on. They never expected to see Mr. O'Donovan reappear, but he had happily returned home in safety, whilst General Scobeleff had found an early grave.

The paper read was—

LIFE AMONG THE TURCOMAN NOMADS.

By EDMOND O'DONOVAN.

LADIES AND GENTLEMEN,—Your Chairman has alluded to General Scobeleff, and his relations with me, and perhaps I could not better open what I have to say than by telling you what my relations with him were. They were not half so agreeable as those of the gallant colonel. In the year 1879, I happened to be on my way towards Thibet with a view of exploring the regions beyond the Himalayas, and giving an account of the Grand Lama; but on my way I learnt of the expedition which was marching against the Turcomans, and, having telegraphed for instructions, was told that I should follow that expedition. I did so, and had the good fortune to meet with the brave old General Lazareff, who captured Kars, and who then commanded at Tchikislar. He received me with the greatest kindness, and while in his camp I had nothing whatever to complain of; but he fell ill, and I fell ill at the same time, and I remember every morning he sent down to my tent to know if I was still alive, and in the evening I sent up to know if General Lazareff was dead yet. He went to the front and died on the way. You all know the story of how General Lomakine took command; he was beaten in the disastrous battle of Geok Tepé, and the Russian forces were thrown back on the Caspian shore. Then General Tergukasoff succeeded, and next General Mouravieff, and those gentlemen would not have—what Lord Wolseley has characterised as "one of the pests of modern armies"—a special correspondent in their camp. So he ordered me across the Caspian with a view of forcing me to Tiflis, and back to the Black Sea. However, by a ruse, I escaped that night. I swam my horses across the Attrek river, and arrived on Persian soil. So much for my dealings with the Russian camp, and my exit from it. General Scobeleff had not then arrived; but afterwards, when I was at Teheran, I telegraphed to him, asking him if he would allow me to accompany the column which he commanded. In the politest fashion he telegraphed back to me, "Having the strictest orders not to allow any correspondent, whether foreign or Russian, to accompany my column, I have much regret in being obliged to refuse you." I telegraphed back in reply that I regretted the necessities of the occasion were such, and wound up with "*Au revoir, Général, à Merv*—we will see who will get there first."

Though it is my intention, to-night, to speak to you about life amongst the Turcoman Nomads, I cannot pass by Tchikislar without saying a few words about it. It was first adopted by the Russian military authorities as the base of operations against the Turcomans, simply because there was the water-course of of the Attrek close by. I have roughly sketched the locality on the black-board, and you see the River Attrek, through a part of its course,

forms the new Russian frontier. The Russians adopted Tchikislar as the base of operations, simply because there was a perennial supply of water all along this line, and where they could not too much intrude upon Persian territory; there was the Sumbar River. There could not be worse anchorage than this, for for ships of a thousand tons have to lie two miles off the shore, and horses and artillery have to be ferried ashore on rafts. You could not well imagine a worse place for disembarkation than this, but when once they had arrived at Kizil Robat, which means the red halting place, they were at the top of the oasis which stretches away to Geok Tepé and Askabad; and having established themselves at Kizil Robat, they had a water-line between Tchikislar and that place, and the railway was now constructed which, in a few hours, took them over the intervening space between it and Krasnovodsk. General Lazareff, who was the first in command here, told me he thought Tchikislar would play a very important *rôle* in the future of Central Asian history; but either he was greatly mistaken, or else he was trying to deceive me. I never believed that, with an anchorage like that in front of Tchikislar, this point could ever be of any great service. At Krasnovodsk there are deep anchorages where ships of heavy tonnage can lie close to the piers, and there is a railroad to take them over the waterless space to a fertile valley, and this I believe is the real base of operations.

Having left Tchikislar, I crossed the River Attrek, by swimming, and also the River Giurgen, and arrived at Asterabad. Between Asterabad and Gumushtepé, I spent six very weary months indeed amongst the Yarmood Turcomans, living in their huts, and sharing with them their daily existence. Being tired of this, and having got a definite refusal from the Russian Government to allow me to accompany the onward march, I proceeded over the mountains to Teheran, about 150 miles. There I appealed to the Russian Minister, with whom I was very well acquainted, to allow me to follow the Russian columns. The result was a distinct refusal by telegraph from St. Petersburg. Then I resolved to proceed by Meshed and join the Turcomans at Geok Tepé, where the great combat took place when the Russians were thrown back to the Caspian. I have put a mark on the board which represents the farthest point which the Russians admit to have reached, but in reality they are up to the River Tejend, of which I shall speak later on. I shall say only a few words about my progress from Teheran to the frontier. It is almost a waterless space, and the only means of irrigation are derived by drilling great well holes in the earth, at fifty yards interval, to a great depth, and tunnelling between them until at a lower slope the water issues on the surface. They are called *canotes*. It is a very special method of irrigation, familiar in otherwise waterless districts of the East. I made my progress for about two-thirds of the distance between Teheran and Meshed, in very curious company, with what was called a corpse caravan; it was very bad company to keep. The people of Persia generally desire to be buried in sacred precincts, and at Meshed is the great shrine of Persia, where Imam Rhiza, the eighth of the blessed Imams, is buried; and from north, south, east, and west, come hundreds of coffins daily, in order that they may be interred close to the golden dome which rises over the shrine. I have been day and night jostled by coffins wrapped up in felt coverings, which had come hundreds of miles, from the corners of which an amber juice was dripping gradually, and when at night we camped, I was obliged to remove my tent half-a-mile out of its precincts on account of the dreadful stench arising from these coffins. But still a corpse caravan was deemed especially sacred, and, as I wished to keep myself very safe on this occasion, I kept with the caravan, even although I ran the risk of catching typhoid fever.

Arrived at a point near Meshed, I knew, however, that certain difficulties lay in my path, and these difficulties were of a triple kind. The Russian Government, after my telegram to Scobeleff, saying, "*Au revoir à Merv*," were resolved that I should not pass the Persian frontier towards the Turcomans. The Russians are omnipotent in Persia; whatever the Czar desires is law to the Shah, and consequently the Shah issued orders that I should not pass his frontier on that side. Again the British Minister in Teheran, with the best intentions in the world, desired to keep me out of harm, and a circular had lately been issued by Earl Granville recalling the fact that some colonels in the vicinity of Constantinople had been carried off by Albanian brigands; that £15,000 had been paid for one, and £10,000 for another; and telling all British subjects that if they liked to put themselves into danger they might get themselves out of it as best they could, and that no money would

be paid for them, not even advanced as a loan. Thus, with the best intentions in the world, the British Minister, at Teheran, threw every obstacle in my way to prevent my proceeding towards Meshed. I had not only to fight against Russian influence, and against Persian influence, but against that of our own Government; and that I assure you, combined with the natural difficulties of the way, constituted no small obstacle. However, in the end, I succeeded in beating them all. Having arrived at a medial point, I parted from the caravan and rode away in the night towards the frontier, hoping to strike the Turcoman lines, but I found that the chiefs had their orders before me, and I was captured and brought back. I once blackened my face and arms with charcoal, put on a Turcoman's disguise, and rode away, but before I had gone two miles I was overtaken. I drew my sword, but I was knocked off my horse and brought back a captive. I fell sick and returned to Meshed. The governor put me under arrest, and told me I might go southward, but not northward. I objected, and only that the courtesy of international relations forbade, I might have been in a difficult position indeed. At length, however, I was allowed to proceed northward, where the Russian frontier is now. I remained for some weary months at a place called Derguez, and there I met with a gentleman whose name must be familiar to you in connection with Central Asian stories—Colonel C. E. Stewart, of the 5th Punjaub Infantry. I was one day in the hovel which they glorify by the name of a house, lying on a carpet on the bare earthen floor, when my servant told me that an Armenian horse-merchant had arrived from Calcutta. I was too vexed at my recent inactivity to think of visiting anyone, but after a couple of days I went down to the caravanserai, and found Colonel Stewart in the garb of an Armenian. He wore a green silk tunic, and brown overcoat, with a short Astrakan shako, and the low upper shoes of an Armenian; he saluted me in the Armenian fashion, but spoke to me in English. He told me he was an Armenian horse-merchant from Calcutta, that he had come to purchase horses for the Government studs in India, and as they wished to cross the strain with the Turcoman horses, he wanted to make some purchases in that neighbourhood. I am well accustomed to the appearance of Armenians in their own country, and I thought Colonel Stewart looked uncommonly unlike an actual Armenian, but as I knew some Armenian families had been 150 years in Calcutta, I did not know what metamorphoses they might have undergone, and what the accent of an English-speaking Armenian might be. It happened to be the Scotch accent, but I accepted it for Armenian. For three weeks we alternately dined with each other, and it was only on one occasion when a Turcoman raid came up to the very gates of the town of Muhammedabad, when the Khan with 500 men rode out, that Colonel Stewart, who I believe to be a very conscientious man, and who thought that the next moment might see either of us shot through the head, did not like to die under false colours. On that occasion, I happened to ask him, "By-the-bye, Ibrahim, how long has your family been in Calcutta?" He said, "I am not Ibrahim at all; there is my name;" and he gave me his card. I mention this, *en passant*, to give some idea of the frontier.

At a place where we lived, very close to the field of action, there was a very curious population, it was not Persian, nor was it Turcoman—it was just on the edge of the Turcoman desert, which stretches away north and east; but here, 250 years ago, under Shah Abbas the Great, and under the celebrated usurper, Nadir Shah, 140 years ago, a colony of Kurds had been established from Western Kurdistan, and Turks, from Khiva, to resist the invasion of Nomads, which the effeminate Persians were incapable of doing. I have lived much amongst the Kurds and Turks, and I remember at Moharrem time the celebration of what would pass in Eastern Europe as "Mystery plays," such as have been recently performed in the Tyrol—the subject being the death of the Imam Hussein—which I, in company with Colonel Stewart, witnessed at Muhammedabad. The play lasts over several days. It is not like a play in this country, where two or three hours is supposed to represent twenty years. The audience were assembled in the open air, and numbered many thousands of men and women. You may not all be acquainted with the story of Hassan and Hussein. They were two sons of Ali, and, consequently, grandsons of Mohammed. They were massacred by what now passes as the Suni, or Turkish party. After a great fight, which was represented in the open-air by men armed with bucklers and sabres, one was captured, the standard bearer of Ali, and I do not think I ever saw such a piece of realistic acting as followed. The warrior, when captured, was dragged away to the top

of a ruined mud caravanserai. He was drawn back with artistic skill, until we lost sight of his head; then his head was supposed to be cut off with knives, and the body was thrust forward, showing the bleeding neck. At first it was an actual man, but a lay figure was substituted, and then was lowered by ropes; and, although his head was gone, the spasmodic action of the limbs was simulated. The fact was, it was in the lay figure, and a small boy sewn up within, gave the necessary movements to the arms and legs. This figure was dragged to a stake and fastened up, still kicking; the executioner approached with a curved knife, cut open the breast and dragged out the lungs and liver—those of a sheep newly killed. He took the lungs and liver, bit them, flung them on the ground, and danced upon them, and then the body was dragged away again. I thought it was the most realistic piece of acting I had ever seen in the world.

Along this frontier you have heard a great deal about Turcoman raids, and the blame attached to them, but I can assure you the Kurds and Turks on the Persian side do quite as much, if not more, in the way of raiding, and, what is more, on the Persian side they bear away spoil which the Turcomans never do,—that is a spoil of heads, for which they are paid at the rate of 10 francs apiece. I remember once seeing a raid coming in, not a mere band of desperadoes, but a band sent out by the legitimate governor of the province, which brought in several wounded prisoners, and several heads. I had asked to see the prisoners. I saw some lying wounded on the ground, and several heads lying around. They told me that out of compliment to me they had not yet skinned them, as they wished me to see the process. In half a minute they had whipped the skin over the head, made a kind of bag of it, trussed it with straw, and tied it up for transmission to Meshed. To save the cost of carriage they took the skin off, because we are not supposed to get the skin of a man's head without having had his head first. I have seen this kind of thing over and over again until I am perfectly convinced that, although the Turcomans may be sinners, they are just as much sinned against by the other party.

I must come now to Merv; the distance from the point of which I am speaking is considerably over 200 miles; it is over 300 by the road you are obliged to follow. I should point out, in explanation of the line I have traced on the map, that it represents the River Tejend, which flows to the westward, then turns to the north, and flows away into a swamp. The Keshef road joins it south of Sarakhs. The Murgab River, which, rising in the Himalayas, flows to Merv, and irrigates the oasis, and also passing northwards loses itself in a swamp. These rivers, in view of the great amount of irrigation which uses up their waters, doubtless once formed what Sir Henry Rawlinson has put down as a great Central Asian lake, which I have very little doubt once existed there, being formed by the conjunction of these rivers with the Oxus, and that these rivers, and this central lake, give fertility to Central Asia. The ruins of domed mosques, and walled cities, standing all over this place, testify to the fact that it must once have been a populous region. I intended to proceed to the scene of the fighting, but, unfortunately, owing to the intrigues of the three Governments, of which one was our own, I was prevented from getting there, and it was only from a distance of twelve miles that I was able to see the final combat at Geok Tepé. I then rode away from where the nominal Russian advance is, to Kelat-i-Nadri, and then began my adventures. When I was at Kelat-i-Nadri, the instructions were, that no Europeans, especially Englishmen, should pass towards the Turcoman lines. There was a time when Lieut. Pottinger held Herat against the Russians and Persians combined, and they feared I might be a second Pottinger. They sent a heavy escort with me, and I arrived at Kelat-i-Nadri, which means the fort of Nadir. I was entertained there for a fortnight very hospitably by the Khan, who talked about Baker Pasha, the celebrated Valentine Baker, and about Major Napier, and others who had visited him, and showed me several breechloading rifles which had been given him. He sent an escort with me to Khaka. The escort was really a party to see I did not go any further. But at Khaka I was glad to meet with a Russian agent, who frightened my escort to such an extent, that they threw off their sabres and boots, and went to bed, and said they would not go any further with such a Kaffir as I was. I then pretended to ride back to Kelat-i-Nadri, to complain to the Khan, but my mind was made up; I rode away southward, and at the moment that the jungle and inequalities of the ground concealed me, I looked at my compass, and directed my road straight eastward, crying, "Bismillah, in the name of God, ride!" We rode away straight towards Merv.

My two servants said, "Are you mad?" I said, "May be I am, but I do not care." We rode straight on, and came on the wild Nomad population, who were astonished at our appearance; however, they received us very hospitably, doubtless because we were armed to the teeth. I remember on one occasion a chief came to me with a number of instruments, more than a foot long, which he told me were keys of the padlocks locking the chains with which my horses were tethered, because, he said, and he thought he was telling me news, "you know we are all thieves here." At all events, they were doubtful about what our mission might be; they were not sure whether we might not be plenipotentiaries, or mighty warriors, or something of the kind, but they let us pass. Then we rode on, and a little before daybreak we reached the banks of the Tejend River, My people said, "We must halt until the dawn; we cannot cross the river, it is too deep—it is dangerous to try and ford it in the dark." When the dawn broke, we saw a river forty feet wide, with a wild growth of tamarisk on either bank; and there were fir and beech, and other north European trees. We tried to ford the river several times, but found that in many places it was too deep. It was necessary to take off our saddle-bags, because, as they held our tea and sugar, and hung down on each side, we were obliged to be careful not to get them wet. Our servants knelt on the saddles, put the saddle-bags over their shoulders, and in this fashion we crossed the Tejend. Then for twenty mortal hours we rode across the desert towards the Murgab. About the space between those two rivers there has been a great deal of controversy, and I should like to tell you something definite about it. Many people say it is a sandy desert, whilst others say it is something else. It is simply a hard marly surface, which is only desert from the lack of water, and you find traces all over it of irrigation canals from the Tejend, which once made it fertile; and all over the place you find vast brick ruins which show that there must have been there an ample population at one time. We travelled over this place for many hours, and came to a place called Kisil-dengli—which means the red monument—where the ground forms a very shallow basin; and whenever there are rains over the plain, the water accumulates to a great extent, and there the Turcomans have erected a kind of obelisk in unbaked brick, which points out to the wanderer over the desert where water is sometimes to be found. When we rode over the place there was no water there, and our horses were sinking from thirst. The water we had brought from the Tejend River was in skins behind our saddles, and, of course, we could not make the horses drink out of skins. We rode on and then came to a place called Shaidly, about 40 miles further on. There we found on a ridge of drifted marly dust, an opening bound round with tamarisk branches leading into a subterranean cistern, and we lowered these very identical nose-bags, which you see here, by our horses' tethering ropes, to a depth of 40 feet, to the bottom of the cistern to bring up some water. When it came to the surface we found it like a weak dose of Epsom salts. Even the horses refused to drink it, and I need not tell you we did not try it extensively. The first mouthful was quite enough. Then we rode further on; night was falling, but we rode on till midnight. We were in the midst of overhanging thickets of tamarisk, which here grows to a size such as you never saw it in Europe. The branches were quite as thick as my arm, and they overhung the road; there were leopards and wild boars, and I was utterly wearied out after so many hours riding, for after all, although I am a pretty hardy horseman, I am not a Turcoman, and cannot keep up with people who were born in the saddle almost. I said, "Let us halt," but they said, "No, we cannot, we are afraid of the robbers;" and considering that robbing was their profession, I thought this was rather good. At all events I insisted, and we drew 200 yards away from the track and laid down. I covered myself with a leopard skin, and with a celebrated old coat, which I am sorry I have not brought here to show you, one which I bought 20 years ago in the west of Ireland, and which I have had with me through many campaigns. When the dawn was breaking, I was saturated with rain. I tried to mount my horse, but he fell on his knees with wretchedness and misery after the weariness of the last night's ride, without food and without water, but still we pushed on, and we came to a place called Dash Robat, within 16 miles of Merv, and the name of which means the halting place in the plain. There we we found the remains of an extensive caravanserai, namely, 200 yards square, an immense pile of buildings with domes, fountains, corridors, and chambers on every side, speaking eloquently of what had been there, notwithstanding the howling wildness which was around it at the moment. We stayed there

nearly half an hour trying to find some fragments of jackdaws' nest with which to light a fire and make our tea, but everything was so wet we were obliged to push on. At last we came within the zone of the Merv oasis itself. The sun was rising, and tall white columns of mist were steaming up from the marshes, and every now and then, like rabbits, great sheepcoated men would start up from the mist and stare at us, as I afterwards discovered they believed it was a raiding party coming in from Persia bringing prisoners with it. I had a white umbrella, which had been given me as a present, and as an umbrella had never been seen in that part of the country before, they thought it was some new engine of destruction, a mitrailleuse or something of that kind. Then an ulster overcoat they had never seen, and the combination of the umbrella and the ulster was too much for them. I rode up to an outlying village, and was straining my eyes to see the domes and minarets of the great Central Asian city of other days. I saw a number of bee-hive huts, barely discernable a mile off. When we arrived, there was a caravan on the point of departure, and several people rushed up and grasping my reins, I was obliged to dismount, and was immediately put into one of the huts. I was asked who I was, and where I came from. I told them I was a feringhi travelling in that part of the world. They asked me whether I was a black Russian or a yellow Russian. At the moment I did not understand clearly what they meant, and committed the mistake of saying I was a yellow Russian, as I thought that was the nearest to my own nationality. To explain this, I should tell you that all Europeans in the eyes of these Central Asian Nomads are divided into two classes, the black Russian and the yellow Russian. The yellow Russian is the Russian proper, the black Russian is the Englishman, not as you might think on account of the distinction between the usual dark whiskers of an Englishman, and the light ones of the Russian, but because they have no knowledge whatever of England beyond Hindostan. They have seen the sepoys who are more or less dark in comparison to the white races who inhabit Turkestan, and the Englishman is called a black man, and the Russian the yellow man; and when I tried to explain later on that I was not a Russian, they said, but you are not black.

I was led up to the central point of Merv, and in the midst of an agglomeration of beehive huts, I found a pale blue tent, a relic of one of the Persian expeditions, which, 27 years ago, attacked the place, and was beaten back with disaster. This was given to me as at once a palace and a prison. They could not be sure whether I was an envoy or whether I was not a spy, and so they compromised opinions. The crowds assembled round that palace every day, so that the tent nearly tumbled down about my head, and, during any month of my life, I never recollect undergoing such persecution as I then did. I had people staring at me through every cranny. I had dozens of elders and superiors, whose rank entitled them to sit within my tent, sitting staring at me, like baboons in a menagerie, with their hands crossed on their knees, and their eyes fixed on me. They seemed to think that they never could see enough of my black tunic, riding breeches, and long boots.

Now to describe to you what Merv is. You have heard so much about Merv, "the Queen of the World," that I dare say you would be glad to know what it is really like. Merv is only an oasis, a watered space amidst a marly waste. It is a mistake to believe that all this country is a desert. It is marked karakoom, which means black desert, but it is no more desert than the ground which Merv occupies. The people of Merv have built a dam at a place called Benti, across the river, which has enabled them to throw out two canals at a high level, and so irrigate a space of ground about fifty miles long, by forty to forty-five wide. The dam raises the water seven to ten feet, and enables these two canals to be thrown out to irrigate the ground at higher levels. This space is occupied by a number of bee-hive huts, called *aljaks* or *evs* or *kibilkas*, according to the different dialects which are spoken; the Turcomans called them *evs*. They are in groups of fifty to two hundred, but there is no such thing as a city of Merv existing at present. About the cities of the past I will tell you later on. These people lead not a nomadic life, for they do not move about; they allow their flocks to wander far and wide, under the guardianship of their custodians; they are, comparatively speaking, a settled people. They are divided into two great sects, the Toktamish and the Otamish. The river flows northwards till it loses itself in the desert; I daresay it formerly reached the Oxus; and to the east of it are the Toktamish, and to the west are the Otamish. They are governed by two hereditary chiefs. The Toktamish are divided into two sub-divisions, the Bakshi and Stitchmaz; and the Otamish, into

the Beg and the Vekil; and these are divided into twenty-four yaps, or sub-divisions. The chiefs on one side and the other are equally powerful; but the eastern chief is the senior, and if a casting vote were to be given, the eastern chief would give it. The Government of the country is, strictly speaking, a patriarchal one. There are twenty-four yaps, or sub-divisions, at the head of each of which there is what is called a kethkhodah, and these, together with the old men and chief men of no ancestral birth, but men who have shown themselves fit to command in battle, meet together, about 200 in all, and that constitutes the council of the nation, always presided over by the chiefs of the Toktamish and Otamish of the east and west. With regard to the name of "Turcoman," some say it is of Turkish origin, and some say it is Arian. Some say it is Tir-coman — *Tir*, an arrow; and *coman*, a bow; and others say it is Turco-man—like a Turk. Turk meaning a wild man. An inhabitant of Constantinople would be highly offended if you spoke of him as a Turk. It would be speaking of him as a wild man of the woods, a savage; he requires to be called an Osmanli. Even in Merv, I found opinion divided as to the meaning of the word "Turcoman."

I am by no means the first person who has been to Merv, but I am the first person who has ever been there since the Turcomans came to it. There have been Abbott, Jones, Thomson, and many others, who went there when it was under the government of Khiva or Bokhara; but, thirty years ago, these people came, and since then nobody but myself ever dared set foot within the place, excepting, I should say, a Frenchman — the Shah's photographer—who had to put his foot in the place, much against his will, as a prisoner. The only place which can be called Merv is the central fortress, and that sprung into existence since my arrival there. It is situated on the eastern bank of the Murgab, and it is called Kushid Khan Kala. The Murgab bends to the westward, and this fortress, which is a vast quadrangle, is formed in the bend of the river. There are 2,000 houses in the interval between the walls of the fortress and the river itself, and this is the only Merv that exists to-day. As regards the old Merv, which lies away farther east, which has been celebrated since the days of Alexander the Great, and where some people say that the legions of Alexander halted; the place where Moore lays part of his scene of "The Veiled Prophet of Khorassan," which he mentions under the name of Merou, which is the Turkish pronunciation; the Turcomans themselves pronounce it as if it were written Mawr. Twenty-five miles to the east, and on the edge of the desert, are the vast remains of the old city where there were formerly two Christian Archbishops, so great was the extent of the population. History tells us when the celebrated Asian conqueror, Genghis Khan, overran the place in conjunction with his son, he slaughtered 700,000 in that place alone. I was once inclined to doubt the truth of this, but after looking over the vast expanse of inhabited country which existed there, I can believe the numbers quite possible. The population must have been enormous, and I think 700,000 people killed, in view of Genghis Khan's character, was not very much, considering what he did elsewhere. There are three old cities; one of which is called Giaour Kali, the fort of the unbelievers; that lies furthermost east, and that is the one in which Moore's scene is laid, for it is that in which the Guebres withstood the might of the Arab conquest. That was about the year 680. These easterns have a superstition against occupying the site of a town when it has been destroyed. Here, for instance, is Giaour Kali, an immense earth embankment, like that of a railway, forty feet high; then the surviving inhabitants moved from that, and constructed another at 1,000 yards distance, which was known by the name of Sultan Sanjar; that was destroyed by the son of Genghis Khan, in the year 1240, and then the people moved another 1,000 yards, and built a new city, called Bairam Ali. Several miles of now utterly deserted country, once thickly built over, spread around these three cities, and that is all that remains of Merv to-day. At present, among these ruined walls, there is nothing but jackalls, snakes, and ravens. I have ridden amongst them, and was obliged to take 500 horsemen at my back, for fear of the Ersari from the Oxus, who might be prowling there.

As regards the produce of Merv, there are absolutely no minerals. It is a white marly soil, which when there is no rain flies into dust, like that of a well-kept high road in England, which some people have mistaken for sand. It is not sand, because it forms mud wherever there is water. The principal produce is barley, which they call *arpa*, *jowane*, the ordinary millet, and the *carpoos* or melon, both the water melon and ordinary melon,

which grow in enormous quantities. Next to corn, these melons are the great produce. I brought back with me the seeds of both kinds of melons, which have a reputation all over Asia as being the best in the world, and which in former times were sent from one Prince to another as being a most acceptable present. Then you have the grape, generally of the muscatel species, an inch and a half in length; peaches, plums, and several species of oil plants; castor oil, the palma christi, kinji yagh, and many others, some of which are used for lighting, and others both for food and for lighting; gunpowder, which is a very important substance, in Central Asia they have one constituent of—nitre. The old sites of former towns and cities destroyed ages ago, require only washing to produce any quantity of nitre. From the Caspian borders, sulphur is obtainable, and charcoal they can manufacture themseleves. I have seen them manufacture gunpowder with tilting hammers again and again. It has a perfectly spherical grain, and is as small as the smallest mustard seed. Apart from nitre, if that can be strictly called a mineral, there are no minerals whatever. From the Oxus to the Caspian, you could not find a pebble even as large as the top of your finger. It is one vast bed of marly soil, perfectly capable of cultivation. As regards the luxuries of the country, there are two, opium and arrack. Arrack comes from the distillation of white grapes; it is an abominable spirit, drunk almost before it is cold from the still, full of methylic alcohol, and maddening in its effect. The people do not much indulge in it, because it is too dear, but opium they are continually smoking. The manner of smoking opium is peculiar. They have a globule of earthenware about the size of an orange, in which a short wooden tube is fastened. At one side of the globe is a minute hole; some opium is taken on a bodkin, boiled over a lamp, tempered and re-tempered, then put in the pin hole, pierced with the pin; held sideways over the flame, and then the smoker absorbs the fumes five or six times, until he falls back in stupor on to the pillow. Then the attendant takes the pipe from him and hands it to the next. It has often been my fate to be in the apartment with several smokers, and I have felt my head reel and stagger under the effect of the opium fumes. Were it not for their opium and other excesses, I believe the Turks would be the conquerors they were formerly.

Their food is very simple indeed. It principally consists of what is called *dhevi chal* —milk boiled and coagulated—thick sour milk, which they eat together with griddle bread. For many months I have eaten nothing but that; they call it *yaghourt*. *Koumiss*, which is valued very highly in London, we drank of plentifully. It is simply the whey of milk fermented, and it is drunk very largely—as we should drink beer in this country. The *koumiss* made from camels' milk is *dhevi chal*.

I see that my own interest in this matter has carried me so far that I cannot go further into the programme I had drawn out, but before concluding, I would say a few words about what is after all the most interesting to us, and that is, what is to be the end of this fight between Russians and the Turcomans in Central Asia; that is, after all, the prime interest of the problem. Why do I and other travellers go to Central Asia? It is not to see what Turcomans eat and drink. It is to speculate as to what is to be the final result as regards ourselves. Now there was a time when I wrote to England that a railway was being constructed from Fort Krasnovodsk, across the waterless desert to Kizil Robat, and across the frontier to the River Tejend. What does that mean? Bridging the plains and deserts, over which troops can only march in limited numbers, and with the greatest loss possible to themselves in horses, camels, and men. I see that on the march from Tchikislar to Kizil Robat there were 60,000 camels lost, and as each camel was worth at least £15, you can imagine what the loss would be in a protracted campaign. This railroad which is constructed is continued close to the upper waters of the Tejend, and from Kizil Robat to the Tejend is a well-watered and well-wooded country. On reaching the waters of the Tejend, forage, wood, and other material in plenty are obtainable, that river flowing as it does from the gates of Herat into the desert. The Russian frontier strikes the head-waters of the Tejend, and the railroad following this would take it away southward; and although the great range of mountains continued in a south-easterly direction, joins with the Himalayas later on, this river has engineered its own way across the mountains, and through those gorges, the railway can be continued to the very doors of Herat, the very gates of India, the entrance to the vale of Candahar. I am sorry I have not got a general map of India on a large scale to point out what the general results would be. The Volga, coming from the north, down to Astrakan, flows past the principal

arsenals of Russia. Then there is the Neva canal, uniting the Baltic with the Caspian. Almost every steamer on the Caspian has been built in Western Europe, and floated through the canal. That will give you an idea of the transporting powers of the canal. Therefore, you have communication between west and east, between north and south; and now that from Tiflis to Baku, on the western Caspian shore, there is a railway, the might of Russia from north, south, east, and west, may be concentrated on this point, and on the gate of India. Then again, since this transporting power has been established, you have nothing but the junction of the line from Merv to Bokhara to unite that with the already existing line, and thus bring into play the whole of the resources of Russia north of the Aral, so as to concentrate all that power together on the entrance to the gate of India. I do not know what your conclusions may be, but those are mine, and I have told them to you honestly.

I have here a number of eastern robes and various articles, which you will be at liberty to examine presently, and here is a carpet from Merv, which I brought with me, and which was made by one of my wives, for I forgot to tell you that I had four wives given to me as a matter of courtesy.

DISCUSSION.

Mr. Martin Wood said every one must feel deeply indebted to Mr. O'Donovan for his interesting and graphic paper. He had not, however, given any explanation of the astounding fact, of which he had brought forward so much evidence, of the immense disappearance of population which had taken place. No doubt to him the reason it was so obvious that he did not think it necessary to mention it; it was probably the denudation of the forests which must have once existed there. Mr. O'Donovan had spoken of Herat under the old-fashioned, almost hackneyed term, the Gate of India. But it was pretty well understood now that the gate was a very long way out, and that there was an immense tract of wild country to be traversed between India and that district, and bearing this in mind, the phrase lost much of its significance. He had followed the progress of Russia in Central Asia for many years, and could therefore contemplate with equanimity the course which was being followed, in what the Russians spoke of as their inevitable destiny. He understood that Mr. O'Donovan expressed a certain amount of agreement with the views indicated by various English statesmen, that after all the Russians, notwithstanding their excesses and abuses, had exercised a certain civilising influence in Central Asia. One memorable expression to that effect was given by Mr. Disraeli, in 1876, when he said, that "so far from being alarmed at the progress of Russian power in Central Asia, he saw no reason why Russia should not conquer Tartary, as the English had conquered India; and he hoped the Tartars would derive no less advantage from conquest by Russia, than the people of India had from the conquest by England."

Mr. Trelawney Saunders said he could not allow this occasion to pass without expressing his sense of the service rendered by Mr. O'Donovan in exploring these distant and dangerous regions. He could not attribute the present degraded and desolate condition into which those countries, once the seat of an enormous population, in a high state of civilisation, had fallen to the mere influence of disafforesting, or any other natural cause. Their condition must be ascribed to the ravages of war, and to the destruction of law, so that no man's life or property was safe, and no man's industry could be pursued with the certainty of reaping any benefit from it. Since these countries were overrun by that scourge of humanity, Ghengis Khan, they had remained a barren wilderness, and so they would remain whilst they were under the so-called government which occupied them at present. But they were as capable of developing wealth, and of becoming powerful as ever they were, so far as their natural condition was concerned; and this it was which rendered them so interesting. They were being approached by two distinct types of civilisation; the one offering to the world at large the same opening that it obtained for itself; whereas the other, which was approaching it from the north, was not content to pursue that liberal course, but, so far as it went, excluded the rest of the world. England was amongst the foremost of the nations of Western Europe who had a large manufacturing population to provide for, and it was a vital necessity to her that these manufacturing populations should have secured for them not only present but also future employment; and it should be the the business of every Government to see that enlarging markets were provided for an enlarging population. He said, without fear of contradiction, that there were no countries on the face of the earth so calculated for the development of these future markets, as those which were once the seats of great empires, and needed nothing but security for life and property to become again the seats of similar prosperity. The interests of England in this matter were the interests of all Western Europe, and, in fact, of the world at large. This was not a party question; both Liberals and Conservatives had combined to place barriers along the same line to the advance of Russia southwards; the first being laid down by a Liberal Ministry, of which Mr. Gladstone was a member, and the second by Lord Beaconsfield; the first one being along the line of the Oxus, and the second the present

frontier between Turkey in Asia, and Russia. But there was an interval between, unprovided for, and that was precisely the part which Mr. O'Donovan had been visiting. That interval was still open to the advance of Russia, and the question was whether the power of Russia was to prevail on the Persian plateau which extended up to the very frontier of India, and the possession of which must be a constant threat to India. The question was whether Russia was to continue to be dominant in Persia, or whether we should, sooner or later, claim a share in the development of that great country.

Mr. MACKAY wished to ask if Mr. O'Donovan considered he had incurred the penalties of the law against bigamy by having the four wives in Merv which he had mentioned.

Mr. O'DONOVAN, in reply, said the title of his paper was "Life amongst the Turcoman Nomads," and had nothing to do with their palæontology; that might explain why he had not touched on the causes of the depopulation of the country; still he was willing to point out for the general information that since the day when great cities occupied those plains, not only had Genghis Khan, and many another conqueror, swept over the country, but rivers like the Attrek and many others had cut their beds, cañon like, to a depth of 90 ft. below the surface, which had rendered them unavailable for purposes of irrigation. He believed that had more to do with the depopulation than any conquest by Genghis Khan. In reply to Mr. Mackay's question, he could only say that the Turcomans did him the honour to give him four wives, but it did not follow that he did himself the honour to accept them. It was simply in courtesy that he called them his wives; they occupied four houses apart from him, and, very probably, they still called themselves by his name.

The CHAIRMAN said he believed there was no one present really in a position to criticise the very interesting paper they had heard. He himself had lived a good deal in Persia, had visited the frontier of Turkestan, and had seen something of these Turcomans, but not much. In 1862, when he first went to Persia, he saw their heads brought in prepared as described, and stuck on poles by the dozen outside the gates of Teheran. He had also seen living Turcomans. As to their dress, weapons, language, and food, they were not at all unlike the wandering tribes of Southern Persia, with whom he had passed some little time. He was rather surprised to have heard nothing about the Turcoman horses, which were very remarkable animals, most hardy and long-suffering. They were long, tall, maneless, and almost tailless—the manes, he believed, were cut off. He remembered once riding one a good deal over 100 miles in twenty-six hours, with a heavy hussar saddle, and two pairs of saddle-bags and blankets, so that the total weight must have been over fifteen stone. The horse did it easily, and was not a bit the worse next day. But that was nothing to what had been done by these horses. In fact, with these horses the Turcomans used to make their extraordinary raids. At the beginning of the present century, there was no doubt they penetrated as far as Ispahan, which must be about 250 miles from their frontier; and that raid had been described, not absolutely as to the precise way it happened, (but in the same way that Sir Walter Scott described the achievements of Rob Roy) in the best book of the kind he had ever read—"Hajji Baba," by Morier. This author described the life of the Persians at the beginning of the present century in such a life-like way, that anyone who had lived in that country recognised the truthfulness of the picture, and as he wrote so remarkably well of the Persians, it might be assumed that he was equally accurate with regard to the Turcomans. The Chairman concluded by proposing a very cordial vote of thanks to Mr. O'Donovan, which was carried unanimously.

A variety of Turcoman dresses, implements, and weapons, were exhibited by Mr. O'Donovan.

TENTH ORDINARY MEETING.

Wednesday, February 7, 1883; T. W. BOORD, M.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Brockbank, William, Brockhurst, Didsbury, near Manchester.
Huth, Alfred Henry, 17, Kensington-square, W.
Joachim, Henry, 25, Phillimore-gardens, Kensington, W.
Mathew, Francis, 103, St. George's-square, S.W.
Moenich, Oscar, 8, Coleman-street, E.C.
Richards, Edwin, Caldicot, near Chepstow, Monmouthshire.
Ricketts, Miss Florence, 1, Gipsy-hill, S.E.
Thorn, Alexander, 1, Elm-park-gardens, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Annett, Richard Charles Francis, Llanwddyn, near Llanfyllin.
Baines, F. E., 12, Park-road, Hampstead, N.W.
Blackstone, Joseph, 6, Albert-terrace, Regent's-park, N.W.
Dacie, John, Soap and Candle Works, Putney, S.W.
James, Richard, H.M. Dockyard, Chatham.
Jennings, James, Marton Grove-house, Middlesbrough.
Knight, John Baillie, Silvertown Soap Works, E.
Moore, Joseph, The Mount, Sevenoaks.

Newton, Francis Murray, M.A., 82, Packenham-place, Dublin-road, Belfast.
Nunn, John Hancock, Norman-house, Hornsey, N.
Sapp, Arkas, J.P., Basingstoke.
Upton, Henry, Marlborough-club, Pall-mall, S.W.

The paper read was—

THE MODERN LATHE: ITS MANUFACTURE AND USES.

By J. H. Evans.

In attempting a paper upon the modern lathe, I must beg for the indulgence of my hearers, by reason of the largeness of the subject, the amount of detail in its appliances for ornamental work, and the want of novelty which my remarks upon plain turning will have to those who are skilled in the art. During the time at my disposal this evening I can, therefore, only give a brief description of the lathe and its adjuncts, but after the reading of the paper, I shall have much pleasure in demonstrating, by means of the apparatus I have brought here for the purpose, any further facts which may be of interest.

About this time last year, an interesting paper was read by Mr. Hasluck in this room upon the lathe from an historical point of view, and I now propose to treat the subject in its purely practical aspect, referring only to the lathe used in the present day, but with special regard to those ornamental and geometric uses of it in which I have been personally interested all my life, and of which I have here several specimens of comparatively simple examples for the illustration of my remarks.

It should be known that the size of the lathe is named after the radius of the cylinder that can be turned upon it, *i.e.*, the distance from the axis of the mandrel to the top of the lathe-bed, thus, when the distance is three inches the lathe is called a three-inch lathe, if eight or ten inches, it is called an eight or ten-inch lathe. For all ordinary amateur and ornamental turning a five-inch lathe is to be recommended.

The lathe-heads and bearers of a five-inch back centre lathe are made of cast-iron. The bearers or bed should be 3 ft. 6 in. long, solid enough to be perfectly rigid when finished and planed up at the top and bottom, and squared at the ends. The top surface of the bed should be finished off and surfaced truly; the slot between the bed should also be carefully finished and left parallel to its sides, and square to the surfaces, and the outside edges of the bearers must be also planed true. The bed should be supported on cast-iron standards, firmly bolted at the ends.

The shape of the mandrel and popit-heads is shown by the examples upon the table; the mandrel head should be nine inches long at the base, and the popit-head four inches, both having a solid tenon of such size as to true up to fit into the interval between the bearers. The mandrel-head must then be carefully set out, its base and tenon planed true and accurately fitted to the bed, the face being planed up at a right angle to the lathe axis. The popit-head is then bored out with a hole three-quarter inches in diameter, and accurately ground out to receive the sliding cylinder; this hole is then used to carry what is termed the centring bar, a long cylinder with a point at each end, which is used for the purpose of setting the popit-head perfectly true, both vertically and horizontally. It must then be planed up correctly, and carefully fitted to the lathe-bed, and in fitting its base and tenon it is necessary that great perfection be obtained, as the ultimate truth and accuracy of the lathe depends upon this point.

Having the popit-head thus fitted to the lathe-bed, and centred to the axis, and the mandrel-head also accurately fitted, the heads are firmly bolted down upon their own lathe-bed. A long drill, with its shaft accurately fitting the cylinder hole of the popit-head, is passed through the front of the mandrel-head. The popit-head, kept facing the same way, is then lifted over to the other side of its mandrel-head, and again bolted down upon its own bed; then the long drill, having been reversed, it is passed through the back of the mandrel-head.

We now have the three holes of the same size, with their axes approximately in the same line, and in a plane parallel to their own lathe-bed. For the long drill, a boring-bar is now substituted; this boring-bar is a cylindrical shaft, which accurately fits the hole in the popit-head; but it is morticed through, so as to carry flat steel cutters of various shapes and sizes, for the purpose of shaping out the aperture in the front of the head to receive the steel collar, in which the mandrel is to permanently run. Other cutters are also used to face up the mandrel-head at the back, so as to finish all the faces or bearing parts true and square to the lathe axis.

In this condition the heads—still firmly bolted to their own bed—are placed between the centres of another powerful and accurate lathe. The finished hole in the front

of the mandrel-head, to receive the steel collar, is tapered about 1-16th inch in its length, which is about one inch, and the back part is shaped out to a curve, to leave the right length of collar bearing. Finally, a vertical hole has to be drilled through from the top as a passage for the access of oil to the mandrel. The back centre cylinder is left carefully true by the drill.

In making the steel collar, a suitable ring of cast steel having been forged, and properly annealed, is chucked and turned out true, the inside being slightly tapered from behind forward, and the hind part turned out to receive an obtuse cone of 45° from the axis; the collar is then fixed upon a true steel arbor and turned outside to fit the tapered hole in the mandrel-head; it should be of such size as to fit into the hole to within about 1-16th of its intended position. The front edge of the collar is then rounded off, and a hole is drilled through it to correspond with the hole drilled through the mandrel-head, and a slight groove for the passage of oil is filed parallel to its axis.

The collar is then hardened, by being made hot in a clear fire, and dipped into clean cold water. In order to fix the collar in its place, the mandrel-head is placed upon a hot-plate or stove, until the face becomes too hot to touch. It will then be found that the cold collar can be easily driven up to the desired position, and the head, on being cooled, will retain the collar in its place. The collar must, of course, be inserted so that the hole which has been drilled in it is in a line with the oil hole in the mandrel-head.

The inside of the collar, having been turned with both its cones fitting a steel gauge plate, to which counter-gauge plates have been made, we use those gauges for turning up the corresponding cones on the mandrel.

In proceeding to make the mandrel, which is made of the very best Lowmoor iron to be procured, it has a ring of shear steel welded on the neck where it runs in the collar, and also at the end another piece of steel for the back centre.

Having carefully centred it, it is turned up all over, and the nose partially screwed. The neck is then fitted to the collar, but leaving sufficient to allow for the contingencies of hardening, and final fitting. Now the mandrel neck or bearing must be hardened, also in clear cold water, and if the result be successful—though failure at this point at times occurs—the back centre is corrected, and countersunk to 55°. and finished, being hardened in the same way. The mandrel will generally have been distorted and rendered uneven in the process of hardening. This has now to be corrected by the process of grinding up by an emery wheel, which is used quite dry and free from grease, and revolving at a very high speed. The emery wheel should revolve in a frame held in the slide-rest, the mandrel also being revolved between dead centres, by a small temporary pulley, in a direction opposite to that in which the emery wheel is revolving. In this way the bearing of the mandrel is ground perfectly true to its back centre, and so as to enter the collar almost completely. This done, the back-centre cylinder should next be taken; this is composed of cast steel, forged to the desired shape; it is turned all over, and the cylinder accurately ground into the hole in the back of the mandrel-head. The point is then turned up to correspond with the centre in the mandrel, 55°, by means of the boring collar, and is hardened. The cylinder slides truly in the hole at the back of the mandrel-head, and is brought forward by means of a circular nut, working against the front face of the casting, which has been trued by the cutter, as before mentioned. Now the final adjustment of the mandrel in its collar has to be effected by grinding in, which is done with oilstone powder, or in some cases with very fine emery. In doing this, the mandrel is kept up to its collar by means of its own back-centre cylinder sliding truely in the back part of the mandrel-head. Great care must be exercised in this process, the mandrel being worked backwards and forwards by the hand until its obtuse cone is brought up into its seat. Lastly, the face of the mandrel and the thread upon its nose is finished off.

A steady pin now has to be fitted to the body of the mandrel for holding the pulley, which is fixed by a nut and washer from behind; the pulley may be of wood, brass, or iron, but for general purposes I prefer iron. The face should be broad enough to show clearly the necessary number of dividing circles.

The popit-head must then have its cylinder finally fitted in. This having been done, the cylinder is bored out to within an inch of its rear end, and coned out in front to take its centres; the rear end is then bored and tapped with a thread of ten to the inch. Its leading screw is then fitted. This has a circular flange at its rear end to bear against the face of the casting, and also against the inside of the metal cap which is screwed on

to the casting; the end projects for the purpose of receiving a winch-handle, wheel, or drop-lever. By graduating the circumference of the flange to hundredths of the circle, the traverse of the back-centre is shown to thousandths of an inch, which, as Dr. Edmunds has remarked, is of great value for accurate boring and other scientific purposes.

Having thus briefly described some of the most important points in making a lathe of this character, we will consider for a few moments a few of the simple tools adopted in metal-turning—that is iron, steel, &c. The lathe will, of course, be the same as used for wood-turning, although for heavy work a back-geared lathe is to be preferred, but this must be according to circumstances. As for hand-tools, a graver, chisel, round nose, triangle tools, and parting tool, will be sufficient for practical purposes. The graver is made of square steel, and ground to a diagonal or diamond shape. Now as to the correct angle at which such a tool should be ground. This is, and always has been, the subject of great comment, but my experience as a practical turner is, that after a very little practice, a workman will grind up the tools to such an angle as will suit his purpose, and cut clean and sharp without paying any attention to the many theories laid down by various authors.

I should like it to be clearly understood that I do not wish to set my face against theoretical science on the point, but I speak from actual experience and observation. You may go in to factory after factory, and see dozens of men grind up tools, place them in the slide-rest, and proceed with the work, but you will not see them testing the tools, to see if they are at an angle of 50° or 60°; the tool cuts, and that is all that is required.

In centring a piece of iron or steel, it is important that it should be drilled up and counter-sunk. This is done with a small drill in the first place, and a half-round counter-sink to follow. The object is to prevent the point of the centre working against the bottom of the hole. The next process will be to face the ends up true. This is done with a triangle tool, which is a tool easily made from a worn-out saw file; I say a saw file, because these, for the purpose for which they are used, are left harder than other files of the same shape, and, consequently, only require grinding. I have brought a few here to illustrate what I mean. Two sides are ground up sharp, and the end diagonally. This tool can be used for either the right or left side of the work.

The object of facing the ends of the material is to prevent its running out of truth, which it ill soon do from the unequal pressure upon the popit-head centre, caused by an uneven surface. The best way to hold this tool will be thus:—The handle grasped firmly in the right hand, with the knuckles upwards, and the tool itself passed between the third and fourth fingers of the left hand; the lower edge of the tool is then brought firmly on to the rest, and by inclining the cutting edge towards the work, it is brought into contact, and those parts that are uneven are soon reduced to flat surface.

To turn a cylindrical piece of steel or iron, the graver is necessary; this tool is held in a similar way, only brought to a different position, the right hand must be more to the front, and the T-rest so arranged that the point of the graver can be brought to the centre of the work. The character of this tool, like many others, will greatly assist the operator in finding the position of the T-rest, that is most suitable to the diameter of the work being turned. With these few remarks upon turning iron and steel, and holding the tools, I will take another branch of metal work, that is, drilling and boring.

In this branch of turning, which is a very important matter, there are various ways and means adopted; work that is held in a chuck, must have a centre formed with a triangle tool, and the drill is made to pass through it by means of the popit-head; if the drill is used between the centres, it is held either by a carrier or a wrench, and sufficient pressure maintained by the popit-head to keep the drill always cutting. In using a drill thus, it will be necessary to be careful to keep the pressure against the centre when withdrawing it: if it is allowed to get free, the revolution of the lathe will cause it to catch and break the drill, and probally damage the operator's hand.

When a long cylinder is required to be bored, the boring-collar must be brought into use; this is a circular plate, with a series of holes coned out from the back. The work is rounded on the front edge, and runs between the plate and the running centre. The centre must be formed in a similar manner, and the drill passed up in the same way; after which, a half-round bit must be used, the mouth of the hole is turned out to fit the bit, which is held in the same way as the drill; for steel and iron, a lubricant of some kind is necessary; either oil or soap suds will answer.

I have great pleasure in saying that, as far

the various chucks for holding drills and small work, our American cousins have made such rapid strides, that they need no comment from me; suffice it to say, that they are a most useful adjunct to any lathe, and as Mr. Churchill is, I am glad to see, in full force, and so able a representative of the American trade, I will leave this matter in his hand, and proceed to give a few details on screw cutting.

Screw Cutting.

I think a word or two on striking and chasing screws will be of interest to many, especially those not far advanced in the art of turning. This, then, forms a very important part in general turnery; screws cut upon ivory or hard wood, for such purposes as boxes, can be cut with a screw-tool or chaser, without the assistance of any special apparatus; but to do this, of course, requires considerable practice, and is what is termed striking a thread.

It will be policy, in the first place, to practice upon inexpensive material, and for wood-screws, boxwood will be the best material. Having the wood chucked in a cup chuck, a plain cylinder, without a shoulder or obstruction of any kind, will be the best to begin with; the cylinder may be about two inches long, and one in diameter, and the chaser should have about twenty threads to the inch. The tool will require to be held somewhat differently to the graver and chisel, the handle is held by the right hand with the knuckles underneath, the left hand is passed round the body of the rest, and the thumb placed on the top of the screw-tool; the rest is placed parallel to the work and not quite close to it, the height being so adjusted that it will allow the cutting face of the tool to be held at a slight angle. When central to the diameter of the material, and about to start the thread, the tool should scarcely touch the flat of the rest, but must be guided by the first finger of the right hand, and the thumb of the left hand. When thus supported, it is moved in a curved line, in the opposite direction to the curved edge of the end of the iron, which must be rounded off. Now, this action, it will be readily seen, necessitates the movement of both wrists, the right going forward for the purpose of advancing the tools, while the thumb of the left hand regulates the speed at which the tool traverses, which rate will also mainly depend upon the pitch of the screw that is being struck.

It will be seen at once that the curved path of the tool being in the opposite direction to the rounded edge of the work, the cut only takes place in the centre of the width of the tool, so that the greatest depth of cut is obviously there. Supposing that what is termed a true lead, is obtained, the same action must be repeated several times, to gradually lead the thread on to the cylindrical part of the work, where it is of course required. When practising striking screws it will form an important feature of the work, that the hand and foot work, so to speak, simultaneously; by this I mean, that the speed of one should coincide with the other; by way of further illustration, it would be impossible to cut a screw of, say twenty threads to the inch, with the lathe running at a high speed.

I need scarcely add that the practice of striking threads is productive of some very curious results, such as double where single threads are wanted, and what is commonly known as a drunken thread; this latter is, I may say, the most common result, and although the term is, I am aware, extremely inelegant, I will ask you to pardon it, as it so forcibly expresses the meaning, and I venture to say that as long as the practice of striking screws by hand is continued, it will be heard far and wide. I will ask the tyro not to be disheartened if his first trials prove fruitless, but to make a determination to overcome the difficulties of what will prove to him a most useful branch of the art of turning, and to bear in mind, at the same time, that if there were no difficulties to contend with, there would be no merit in endeavouring to become efficient.

I will now proceed to describe the traversing mandrel, which offers a means of cutting such screws mechanically. It is largely used by amateur turners, as striking screws with certainty requires continual practice. It will be found to overcome all difficulties and to be extremely handy.

In the traversing mandrel the lathe-head casting is about the same substance of the ordinary back centre lathe, but both ends are more nearly alike. The mandrel, however, is made sufficiently long to project at the rear. It is made of the very best cast-steel, and should always be bored throughout, its bearings are cylindrical, and the cylinder is hardened at those parts which run in the collars. The front of the mandrel has a cone left on it of 45° fitting to a corresponding cone in its collar, and this stands in the reverse direction to the obtuse cone of the back centre lathe. When being used for plain turning it is kept in its place by a steel cap, fitting over the back end

of the mandrel, and bearing against the face of the collar. This cap is prevented from turning round by a steady pin in the end of the mandrel, passing through a corresponding hole in the mandrel, and is retained there by a screw which fits into the end of the mandrel. On the end of the mandrel, steel screw-guides may be substituted for the cap, and secured by the same screw. Six of these generally accompany a high class lathe of this kind, and are found to be sufficient for all practical purposes. The conductor is made of either brass or gun metal, and consists of a ring cut into segments, severally screwed to correspond with the steel guides; the ring is then fitted on to an eccentric mounted on a stud under the centre of the mandrel at the back of the head. The metal guide works freely on the eccentric, but to fix the guide selected for use in contact with the steel screw-guides, it will need the use of a lever. By means of this guide the mandrel is quite under control of the conductor, and, with the guide on the mandrel, is compelled to work backwards and forwards, according to the pitch of the guide and the direction in which it is turned. The obsolete fractional pitches I have now abolished, and I screw these guides with six convenient aliquot threads, each guide being clearly marked with the number of threads to the inch which it cuts.

The pulley, which is also made of brass or gun metal, should receive careful attention in its construction. It is made hollow to avoid weight, but is turned all over inside, so that it is equally balanced when put together. I find, from experience, that the best way to put such a pulley together is to shrink the face in. Some makers, I know, solder them, but I think the former way preferable. The inside having been carefully turned all over; the front is then turned out 3-16ths deep, and under-cut. The face is then turned to a corresponding angle, and left 1-16th larger than the recess. The body of the pulley is then placed on a heating-stove, until it expands sufficiently to admit the front, which is pushed in, and then allowed to cool, when it will be as solid as if it were one piece. The centre hole is then turned out taper, and the mandrel fitted accurately to it. As only a small face can be left on the mandrel, it is necessary to fit to it a steady pin, and the pulley being cut out to fit it, a nut and washer behind the pulley fix it securely to its place.

On the face of the pulley eight circles of divisions are drilled, viz., 360, 192, 144, 120, 112, 96, 60, 12, an adjusting index is also an indispensable addition. I may mention that I put the division of 12 for dividing squares and hexagons, as it saves the wear of those that are required for ornamental turning. Such lathes are usually mounted on a strong double frame of mahogany, which checks vibration and deadens sound.

Having briefly described the construction of this lathe, I will give a few details of the manner in which it is used. It produces both internal and external screws, with absolute certainty, and this, it is needless to say, reduces the difficulties of screw-cutting to a minimum; where its advantages are most obvious, will be found in such work as an ivory box with a short screw, and only sufficient material to fit the top and bottom together, so that a failure in striking the screw could render it useless.

The work being turned to the size required, the cap at the rear end is removed, and the steel guide, whichever is selected, put on its place. The corresponding screw in the conductor is then placed under it, and the eccentric turned round until it comes in close contact with the guide, so that it will work without any shake. The motion being now given to the mandrel, it travels forward at the rate given to it by the pitch of the screw on the guide; the T-rest must be so arranged that the mandrel will recede without running away from it, at the same time it must be placed so that the face of the work will not come in contact with it.

The fly-wheel must not take an entire revolution, but work backwards and forwards, the throw of the crank pointing each way alternately. This will require a little practice. The action must be as regular as possible, and the foot should not leave the treadle. It will be observed that the fly-wheel, being very much larger in diameter than the pulley on the mandrel, its partial revolution causes the pulley to make several complete turns, sufficient for all short screws. And where a longer screw is required, the cap may be replaced, and the thread carried along, which, having obtained a true lead, will not be found such a difficult matter.

I will, with your permission, now proceed to a description of a few of the more complex tools, used for ornamental turning. First, I should like to dispel the prevailing idea, that before any work of this kind can be accomplished, a very large outlay is necessary. It is no use my trying to hide the fact that ornamental turning is a somewhat expensive hobby,

but still, with a good lathe and some of the more simple instruments, a very fine collection of specimens may be produced.

A short list of the instruments necessary for this may be useful. Assuming, then, that a well-made lathe (traversing mandrel will be best) is obtained, all that will be wanted, in the first place, will be an overhead motion, compound ornamental turning slide-rest, eccentric cutter, a vertical cutter, and a drill-spindle, with about three dozen cutters to each.

1st. The overhead motion; there are various descriptions of these, that upon the suspension plan is still made by some makers, and is a very useful form; but, at the same time, there is room for considerable improvement, inasmuch as where a number of instruments with any considerable difference in the size of the pulley are used, separate bands are necessary.

In the one you see attached to the lathe I exhibit, you will observe that there are two standards, one being fixed to each side of the lathe-frame by strong bolts; accross the top a triangular bar is fixed, by a nut at each end also. There you will see a rigid framework is formed, upon this bar a metal carriage is fitted, which slides from end to end; upon this again is fitted another crosspiece, working upon two centres, through which another long bar passes, having on the rear end a counterbalance weight, and in the front a pair of guide-pulleys; these are for the purpose of conducting the band, from the drum that works below, on to the instruments that are used in the slide-rest, the round bar, as you will see, carries a long drum for spiral work, and a metal pulley, which is driven from the fly-wheel below. The advantages of this pattern are, in my opinion, first, that it facilitates using the whole length of the bed, if desired; secondly, that one band will answer for all the instruments; thirdly, that the tension upon the band can be more readily adjusted; fourthly, it is more steady and less likely to vibrate, which is an important thing.

I may mention that the best proof of the advantages this has over other patterns, is the large number that have been made, not only by myself, but by other makers.

We will now consider the ornamental turning slide-rest, a few details of which will probably be of interest. This is an instrument which forms a most important part in ornamental turning, and one in which perhaps more improvements have been made than in any other parts of the lathe, especially within the last few years. The original rest, of which this is one, was, as you see, extremely short, and fitted only to a common rest-pedestal without any means of adjusting the height of centre, or to turn a surface and cylinder, beyond using the T-square, and raising it by hand. These movements were, under any circumstances, uncertain. The next advance was a ring fitted under the top slide, to raise and depress the height of centre; but the means of setting with any certainty, to turn a surface or cylinder, were still wanting. Without dilating further upon obsolete tools, I will now give a few details of those now made, and I think the slide-rest I have here will clearly illustrate the advantages they possess.

You will see that a metal cradle is fitted to the lathe-bed, and a transverse fitting is planed perfectly square to it; when this is done the body of the rest is also planed to fit it; the metal cradle, having one side loose, it can be adjusted to slide most accurately; the body of the rest is then carefully chucked on a true face-plate and bored, or turned out to $1\frac{1}{2}$ in. diameter; that part upon which the ring works must be screwed before it is removed from the chuck. In making a rest of this description, great accuracy is required, and this will depend in a great measure upon the truth of the chucking and turning. The body, thus far, is ready to receive the stem of the main slide; this should be carefully planed up, and then chucked on the face-plate in a similar way, and the stem fitted accurately to the hole. These form the most important fittings, and, if properly done, it will be obvious that, when put together, whichever way it is turned, or in whatever part of the slide the tool is used, it will be positively at the same height of centre. I need scarcely point out that, if the hole is not bored true to the face, the upper slide cannot be correct, and if the error is of the most minute degree, it will multiply to a very serious extent in the length of the slide. The metal ring used for raising and depressing the height of center has now two screws fitted at opposite sides, their purpose being to fix the ring when the height is determined. Until these were introduced, considerable annoyance was experienced by the tool being at different heights when turned from one point to another, and it was found that the weight of the top part of the rest carried the ring round with it, and consequently caused the difference; the fixing screws, however, entirely overcome the difficulty.

We now come to the upper part; it will be seen

that in this we have several improvements. First, by an extra collar on one of the adjusting screws, we are able to place the top slide under control without the use of the lever at all. I know many gentlemen who have turned for a long time, who still prefer the lever, but when used to the screw I consider it a great advantage, and never use anything else myself. Another addition is the metal cover to the main screw for the purpose of keeping the shavings and dirt out of the screw, this saves a deal of wear and tear, and inconvenience to the turner. The main screws both for the long slide and the top are all made ten to the inch.

I am now making another slide-rest of a still more elaborate description; it has a longer main slide, and the upper part is fitted with a quadrant to the slide, this enables the tool to be set at an angle without altering the lower part, and is of great service when using moulding tools, either fixed tools, or revolving drills. On the end of the screw a tangent wheel is fixed, which forms the micrometer for the divisions in the front; a tangent screw fitted to a metal frame is thrown into gear by a cranked lever, and can be made to act instantaneously. This screw having a pulley on the end, it can be driven from the overhead motion, and a self-acting cut can be taken its entire length. I will point out an improvement I have made in the fluting stops, which, for accurate work, has been found a great help. The plain stops it will be seen have a set screw which passes through the centre, and are sometimes divided on the head, a reading line being marked across the metal; as long as the head of the screw and the line are close together they will answer, but for doing large star patterns, I found that it was impossible to read accurately when the lines became separated, which they do by the movement of the screw. To overcome this I have introduced what may be called a spring reader, this being cut out to fit the screw head, the lines are always close together, and can be read with the greatest ease and accuracy.

The metal-turning slide-rest again is a most useful tool, not only for turning metal but for roughing out large pieces of wood. There are various descriptions of these rests. The one generally made to accompany ornamental lathes you will see exhibited on the table below; it consists of a metal cradle fitted to the bed of the lathe, having on one side an angle, the other square; a massive cast-iron base is fitted to this, on the top of which another slide is fitted. I have now adopted a new plan of arranging this slide, that is, to make it take a complete revolution, by fitting the holding-down bolts into a T-groove. There are several advantages derived from this. In the first place, the slide can be brought round so that a surface cut may be taken with the main or lower slide; this, I consider, offers a considerable advantage over having to use the top slide, which must bear all on one end, when used for the same purpose. Then again, the fact of being able to turn the slide to any desired position without removing the bolts to different holes, is of great importance, and there being no quadrant slots for the bolts necessary, there is no opportunity for shavings, &c., to get in. Another improvement is, having a powerful dovetail slide fitted to the lower part to hold it securely to the bed instead of relying upon the cradle to do so.

We will now pass on to consider the eccentric cutter. This is made to run in a steel stem, which fits into the tool-box of the slide-rest, and is driven from the overhead motion. It has been suggested by many gentlemen that I have met in the course of my experience, that the eccentric cutter and eccentric chuck are identical in their productions; to a certain extent the remark applies, inasmuch as many patterns that can be executed with the cutter, may be done with the chuck, but in working them out separately, it will be found that a vast number of very beautiful patterns can be cut by means of the chuck that could not possibly be done by the cutter. Then, again, we have the combination of the two, the effect of such work being very interesting indeed. First, then, with the eccentric cutter; all such patterns as represent the intersection of circles are easily cut, and the variety may be said to be infinite, for the simple reason that a very slight alteration in the settings will make quite a different pattern. There are various ways of altering the aspect of the work, either by a different division on the pulley, a more or less acute angle to the tool, or a larger amount of eccentricity to the cutter. The pattern that is generally practised first is what is termed the barleycorn. This is cut with a double angle tool, of about 45°, and a division that is most suitable to the diameter of the material. The diameter of the circle cut is also governed in the same way. Having cut a series of patterns with the double angle tool, it will be interesting to study the different effects to be obtained by the two single angle tools, which

are made to cut right and left, but otherwise used at precisely the same settings. As for the double angle tool, the different effects will be so apparent, that it will be unnecessary to expatiate further upon them.

In these three tools, we have those that are principally used with this instrument for face work. There are, of course, a large variety of tools of different patterns, such as round nose, hollow, bead, quarter hollows and rounds. These are used for working up mouldings and many other purposes.

Another great advantage of possessing an eccentric cutter is, that it is capable of being used for cutting squares, hexagons, octagons, &c. This is done by extending the eccentricity to cut a circle rather larger than the size of the surface required; this done, the cutter is driven at a high speed, and passed along the surface by the movement of the slide-rest. A certain amount of beautiful work may be done on the dome or sphere chuck, by turning the work in the first instance to the shape required, and then adjusting the radius of the cutter to suit it; by a variety of setting in this way some very beautiful work is produced. Having described a few of the capabilities of this instrument, I will pass on to a brief outline of the eccentric chuck, its movement and results. In making a chuck of this description, it will be necessary that the greatest care should be exercised, for the simple reason that if it is not absolutely true in all its parts, it will be impossible to do accurate work. The first thing to do will be to screw the back so that it will stand at a right angle to the bed of the lathe when the index points to zero. This done, the face must be carefully turned over, and surfaced; the steel slides are then fixed to it, and the front plate fitted, equal care being given to this also. You will see, by examining this chuck, that the slide is capable of being advanced from two to three inches, and if there is the least error at starting, by the time it is moved a very short distance, the error will be so multiplied that it will be useless. And now as to the work to be done by its aid; if for patterns similar to the minor productions of the cutter, it will only require the slide to be set out the required distance, and a fixed double angle tool in the slide-rest, then by dividing the front wheel of the chuck, a large variety of patterns may be executed.

Another pattern, which is very effective, is what is termed the geometric staircase. This is done by extending the slide of the chuck, and using a fixed tool in the slide-rest, which should be a square-ended chisel. It will be as well to point out that for this pattern a larger diameter must be left than is required, in consequence of a considerable part being cut away on one side, caused by the eccentricity given to the slide. As an example of this pattern may be useful, I will give the details connected with it. In the first place, the work, which will consist of a plain cylinder, must be turned on the eccentric chuck, and if sufficiently long to cause vibration, the popit-head centre must be used to steady it; the end of the wood must be carefully faced up. It will be necessary to see that the dividing wheel in the front of the chuck is set at the starting point 96. The tool, which is fixed in the slide-rest, should be 1-10th wide, and the reader on the main screw set at zero also. Having them all at the centre, we may proceed with the first cut, having first set out the slide of the chuck two turns. The tool must then be carefully inserted until a complete circle is cut, and when this is done, the stop screw of the top slide must be fixed. The tool must be withdrawn, and the popit centre released, the dividing wheel moved round 12 divisions, and the slide-rest moved one turn, which will be the exact width of the tool. This done, the second cut may be taken, but before doing so the popit centre must be replaced. It will now be seen that when this operation has been repeated eight times, that the dividing wheel has made one complete turn, and that the end of the wood has eight separate centres. It will, therefore, be necessary to release the popit centre, and replace it for each consecutive cut. I have a few samples of this work amongst the specimens that are exhibited here, which will show the result perhaps more clearly.

We will now take a brief outline of the drilling instrument and its uses. This is made to run in a square stem in the same way as the eccentric cutter, and the drills are made of a variety of patterns; and for fluting, cutting beads, piercing fine lace patterns, it is of course indispensable. It is an instrument that requires very little explanation, and the various shaped drills will denote the pattern they produced. Very beautiful effects are to be produced by an extensive use of the division plate and slide-rest, in conjunction with it.

The next instrument I shall refer to is the vertical cutter. This is also made with a square stem, but the spindles run between two centres. There are, however, several patterns of this instrument, and the most useful is, I think, one that was invented by Dr. Stodarts.

The spindle running in a collar, the frame is dispensed with, and enables the cutter to be brought closer to the collar of any work that is being turned. One of the most effective patterns to be cut with the vertical cutter is the basket pattern: of this a number of different designs may be made. The way to proceed is to take the first cut round, arranging the index point and division plate so that the points are brought up sharp. Having cut round the entire circle, taking, we will say, 12 divisions of the 96 circle, the slide-rest must be moved the exact width of the tool, the divisions advanced 3 holes, and a second cut all round, taking 12 divisions again; this must be repeated as many times as required to complete the pattern the entire length of the work. Another effect may be obtained by cutting half in each direction, that is, when the centre is reached, the divisions are taken in the reverse way, which, in other words, will be back again. By varying the division, a great many different patterns are thus produced.

We have now taken a brief view of those instruments I have named as forming a sufficient outfit to begin ornamental turning with.

Before concluding my remarks, I must refer to a very important discussion which has recently taken place in the Council of the Amateur Mechanical Society, and by means of which, certain very necessary and desirable conclusions have been arrived at. These conclusions are as follows:—

1st. That the obsolete and inconvenient screw pitches, which have hitherto been used in the manufacture of our ornamental lathe work, should be supersed by threads of aliquot pitch, that is, by screws which are pitched at an aliquot part of our English inch.

2nd. That the mandrel nose and back popit cylinder should be screwed at the rate of ten threads to the inch, which is the same as that already adopted in the screws of the ornamental slide-rest and eccentric chucks. Hitherto, the mandrel nose has been screwed 9·45 threads to the inch, and the back popit at various fractional pitches.

3rd. That the cross-section of the thread of the mandrel nose, and other fine screws for scientific and ornamental lathe work, should be an isosceles triangle of 50°, the top of the thread to be flattened off, or rounded down to the extent of $7\frac{1}{4}$ per cent. of the height (more exactly ·0723 of the height), so as to form a thread, whose altitude and base are equal.

4th. That the groove hitherto turned out at the base of the nose of the mandrel, be replaced by a short cylinder, larger in diameter than the outside measurement of the thread of the nose.

In acknowledging the fact that this advance is due to the action of the Council of the Amateur Mechanical Society, I may perhaps venture to say, that when scientific amateurs, such as Mr. Boord, Dr. Edmunds, Colonel Sandeman, Mr. Henry Perigal, and others, devote their attention to constructional questions, the result is always advantageous to science, and helpful to technical workers. To Dr. Edmunds, as a member of the council, is to be ascribed the initiative and the zeal which has carried this matter through; and I am bound as a practical mechanician to testify to the advantages that will arise from the action thus taken by the Council of the Amateur Mechanical Society.

Having said so much, I will briefly describe the new mandrel nose. It has long been a complaint that the old pattern having a thread of 9·45 inch pitch, created difficulties to amateurs in the screwing of their chucks, although, as lathe makers, we always supply special taps for the purpose. Another objection is, that being grooved out at the base of the nose, while the centre of the mandrel is bored out, it is considerably endangered, that very part of the nose where the greatest strength is required being in fact, made the weakest point.

Then, again, the shape of the thread from a scientific point of view has been imperfect, inasmuch as its height is greater than the length of its base, while its angle has not been precisely defined, and in practice has varied considerably. Although I have produced a very large number of the old pattern, I am quite of opinion that it is time an alteration was made, and a definite scientific standard adopted. This may now be said to be done, and I have made arrangements for my new lathes to be made to it, unless especially ordered otherwise.

The details of the new standard mandrel for ornamental lathes are as follows:—The diameter of the mandrel nose is ·9-inch, and its length over all is also ·9-inch, with a cylinder base ·15-inch in length, and larger than the top of the thread. The thread is ten to the inch, and its shape that already defined by Dr. Edmunds, and recommended by the Council of the Amateur Mechanical Society. The face is left perfectly square, no recess whatever being turned at the base of the nose. The mandrel nose being now larger in diameter, admits of the end being coned out slightly to receive a variety of small chucks for delicate work; the screw at the end of the mandrel, which holds the cap

to its place, is also bored through, so as to allow a slender rod to be passed through from behind without unshipping anything. The cylindrical base ·15-inch in length, is ·95-inch in diameter, so as to allow the mouth of the chuck to pass clear over the top of the thread.

This is not the first time that the ornamental lathe is indebted for its progress to scientific amateurs. Professor Willis's tool-holder; the ellipse cutter, by Capt. Ash, with its indispensable tangent compensator, by Mr. Perigal; the geometric slide-rest by Capt. Dawson; the geometric chuck by Mr. Ibbetson, and many other improvements, have emanated solely from the ideas of scientific amateurs.

I have one of the new mandrels here, and will ask those interested in such matters to kindly inspect it, and perhaps Dr. Edmunds will kindly say a few words on this important subject. I may mention that the fact of the council having decided upon this new standard, will not, of course, in any way interfere with my making the old pattern for any one desiring them.

DISCUSSION.

Dr. EDMUNDS said he believed the use of the geometric lathe, with which a great variety of beautiful work could be done, had not been fully appreciated as an educational instrument. For instance, children might be taught by very simple demonstrations, a number of geometrical notions which were now hammered into their brains with the greatest difficulty, and not always with the best results. A gentleman might spend from £200 to £800 on a lathe, and he had known some gentlemen who had spent as much as £2,000 on this beautiful apparatus, but nearly all the ornamental works which Mr. Evans had shown could be produced with a lathe and a few tools costing not much more than £100. But the important point was this, that almost the whole of such apparatus was dependent for its value on the mandrel. No pains, therefore, should be spared to make this a gem in mechanical art, so perfect, that a gentleman possessing it might go on investing hundreds of pounds and know that he was accumulating instruments of permanent value. But if he began with a mandrel made so that the nose broke off, the whole of the apparatus turned up upon it was rendered useless. All these costly things could never be put on any other mandrel; at any rate, not without very expensive refitting, and without great difficulty in getting them to centre anything. Why were not mandrels interchangable? In the first place, a chuck put on a strange mandrel, which would fit it up to a certain point, might vary slightly in two ways—either in an angular direction, or, in cylindrical centring. If it varied angularly, the axis of the chuck would describe a cone when in use; if it was not exactly centred, it would work as if it were slightly decentred parallel to the lathe-axis by an eccentric chuck. Into those two forms all the variations of a chuck on a mandrel might be resolved. One defect in these mandrels was that the face was a great deal too narrow; because, however accurately the chuck were fitted, when it came against a narrow face, there was not leverage enough to keep it true, and not bearing enough to minimize the irregularities of its base. Therefore, a chuck upon a narrow face was more likely to deviate in an angular direction than if there were a broad face. This broad face was just as easily made; for many chucks it was absolutely essential, and it would be one step towards making mandrels interchangeable. Then came the question of eliminating the decentreing of the axis of the chuck. In the present ornamental mandrel there was a groove turned at the base, which could only tend to weaken it. He would have a cylinder left on the base of the nose, which would not only strengthen it in the place where it most wanted it, but would centre the chuck, and thus the tendency to eccentric variation in the axis of the lathe would be controlled. He produced a wooden mandrel, turned up by himself to show the face and nose, which was true all over, within a small fraction of 1-1000th of an inch. It had a cylinder at the base of the nose ·15 inch long and 1-20th of an inch larger in diameter than the top of the screw thread; a chuck could be turned to fit it within a fraction of 1-1000th inch over that; and if you took two things fitting within a fraction of 1-1000th of an inch, you reduced their variation within a fraction of 1-10,000th. In fact, you might thus reduce the variation of a chuck upon a series of model mandrels to about those limits which were found to exist between consecutive fixings of the chuck upon its own mandrel. If that were so, then, in mandrels made with the care and thought which such important instruments required, they might get rid of both angular and eccentric variation in chucks not made specially upon them, and these things could be bought and sold independently of their lathes. Mr. Evans, he saw, seemed to have some doubt about that, but, at any rate, it was an object well worth striving for, that all these valuable things should be capable of being transferred from hand to hand, and of fitting on any standard mandrel in precisely the same way as any Whitworth ring gauge would go on any Whitworth cylinder guage. With regard to the screw-thread, hitherto amateurs had been victimised by obsolete threads, which mechanical engineers would refuse to have in the most paltry apparatus. To this day the screw on the nose of these costly mandrels was made with a pitch of 9·45 threads to the inch instead of 10, whilst the screw at the back-centre was 13·09. The result was that if anybody wanted to know how deep his drill had gone, he had to divide an inch by 13·09,

and multiply that by the number of turns of the back-centre, and then he got the result. Now, if only the screw were made with ten threads to the inch, he would simply have to read the number of turns he had given the back-centre, and would have in decimals of an inch the depth he had bored. It was the same with the other screws. In fact, they still had a whole series of screws which could not be made by change wheels, and could not be produced except by getting a copy from the particular manufacturer who sold these tools. These screws had been kept up for no other purpose than to compel amateurs to go to the particular maker who made the lathe. If you bought such a lathe, you became a slave to its maker; nobody else could make a screw for it; if you went into the country, or to Australia, you had to send the lathe to the maker to get a screw for it, which, if it were a standard screw, you could buy for a few pence, or could originate for yourself. The thread itself again had had no definition; one was "about 50°," one "about 60°," and the deep thread of "about 50°," in point of fact, varied from 45° to 55°. They ought to have a screw which, in itself, possessed true scientific merit. In a screw there were two elements, the thread, and the stem which carried it. If you screwed it into an iron plate, and then set an engine to pull it out by main force, either the thread would strip off, or the stem would break. It could be shown mathematically that there was a certain distribution of the material of the thread of a screw which would give the greatest possible strength, combined with the greatest durability under the wear and tear of frequent fixing and unfixing. The perpendicular of the isosceles triangle, shown by a cross section of the thread, represented the longitudinal hold which the thread took against its abutment when it was turned in its nut. If the base of the triangle were shorter than the altitude of the thread, it would bend over or break from its base before its full hold could be taken. If, on the other hand, the base were made longer than the altitude, material would be wasted, undue burstiug strain would be put upon the nut, greatly increased tendency to abrasion of the surface of the thread would exist, and fewer threads of a given altitude could be cut upon a unit length, say an inch, of the stem of the screw. Speaking roughly, these considerations applied to steel and all materials, which must be taken as homogeneous, but in wood the thread is required to have a base longer than its altitude if the grain runs parallel to its base. Such a thread was obtained by an isosceles triangle of 50°, truncated at its apex to the extent of $7\frac{1}{4}$ per cent. of its pitch. The point tool, if kept absolutely sharp, would leave a minute groove below the flattened top of the thread, and this would receive minute particles of foreign matter, and hold oil. Where the strength of the stem was important, the point of the tool might also be flattened down or rounded off some 7 per cent. of the pitch of the thread. This thread, the Council of the Amateur Mechanical Society thought, must be recommended on its merits, and as it could be made with perfect ease, it was preferable to the Whitworth screw for that reason. It could be made by a simple geometrical arrangement of the slide-rest, and calippering of the cylinder out of which it was cut; whereas, the Whitworth screw, while an easy thread to cut for rough purposes by the ordinary hand tool, was exceedingly difficult to cut for scientific purposes in a screw-lathe. In rounding off 1-6th at the top, and 1-6th at the bottom, you require to continually vary the arc of the circle in relation to the pitch of the screw. The thread of 50°, truncated to the extent of $7\frac{1}{4}$ per cent. of its pitch, had other advantages besides the distribution of material. The depth was always exactly equal to the pitch, and that got rid of numerous calculations. In cutting a screw of ten threads to the inch, each part of the thread was ·1 inch deep; you had not to refer to any tables. If you had a cylinder of ·9 inch diameter, you knew you had ·1 taken off each side from the diameter of the bolt by the incision of the groove, and an untouched stem of ·7. If, again, you had twelve threads to the inch, you took off one-twelfth on each side, and so on with any number of threads. He congratulated Mr. Evans on having taken up the matter. If he (Dr. Edmunds) had inherited from his grandfather a set of lancets, and thought it necessary to bleed his patients rather than keep them idle, his patients would quarrel with him or leave him; and if gentlemen who stood in a fiduciary relation to amateur mechanicians and happened to have inherited an old set of screw-tools, insisted on putting these obsolete screw-threads into hundreds of pounds worth of apparatus, he thought their customers would leave them also. The Council of the Amateur Mechanical Society were much indebted to Mr. Evans for the active practical interest he had taken in this question, and for the manly way in which he had consigned his present screw-tools to the repairing shop, and set about making the new standard, which had now the authority of being recommended by a perfectly impartial body like that of the Council of the Amateur Mechanical Society.

Mr. SMYTHE said the mandrel which had been shown was a most excellent one. He would advise any amateur beginning turning to see that they had a good head to start with, and then the mandrel might have either 9·45 or 10 threads to the inch. He was a member of the Amateur Mechanical Society, but he had not yet been consulted on the advantages of the thread described by Dr. Edmunds, on which he should like to say a word. Though the top might be cut off, the bottom was so sharp that he feared the presence of little particles of dirt, which were always liable to get in, would spoil the chucks and interfere with the tools in every way. His advice to the members of the society, was to wait a little longer and see if they could not improve even on what was now suggested.

Mr. BOYLE believed the screw proposed by Dr. Edmunds would be found to be identical with that which had been adopted as the standard in America, on the advice of Mr. Sellar, an eminent engineer, in preference to the Whitworth.

Dr. EDMUNDS said he believed the pitch of that screw was 60°.

Mr. BOYLE said it was very small: it was cut off straight at the top, and had also a corresponding cut at the bottom of the thread, the absence of which Mr. Smythe had observed upon.

Mr. H. T. WOOD (Secretary) said that a committee was appointed at the meeting before last of the Mechanical Section of the British Association, to consider the question of threads for small screws under a $\frac{1}{4}$-inch, with special reference to the screws used in electrical work, and watch and clock making. That committee had been sitting for about eighteen months. It had already presented an *ad interim* report, and would probably present a complete one at the next meeting of the Association. He should like to ask Dr. Edmunds whether the Amateur Mechanical Society had really made up their minds to go in the face of all experience by refusing to use what had long been the national thread, and was really becoming universal—that introduced by Sir Joseph Whitworth. In that thread, height was practically the equal to the pitch, so that it really possessed the theoretical advantage claimed by Dr. Edmunds for his screw. As to the new shape of thread, it appeared to him, with all deference, an unmechanical arrangement to cut a piece off at the top and not at the bottom, because when you screwed one screw made in that way into another, you had two surfaces together of an entirely different shape; and the surfaces were not in contact. The advantages of uniformity were so obvious that they hardly needed discussion, the British Association Committee had felt this so strongly that they proposed to adopt the Whitworth shape, even for the small screws they had to deal with.

Mr. MASSEY thought Dr. Edmunds had intended to say that the apex of the thread was truncated, both in the external and internal screw, which would leave plenty of room for the little bit of dirt referred to by Mr. Smythe.

Dr. EDMUNDS asked if Mr. Wood was certain about the Whitworth screw having the same depth as the pitch.

Mr. WOOD said it was so stated in Molesworth.

Dr. EDMUNDS said Molesworth must be wrong; the angle was 55°, which was greater than the one he had shown. If you had a triangle in a square, the height of the triangle was equal to its base, and of that triangle, the upper angle was 53° 8′, a little blunter than he recommended. Sir Joseph Whitworth's was blunter still, and he cut off 1-6th at the top, and also at the bottom, which would make the depth about 2-3rds of the pitch. With regard to the bottom of the thread, you could not use a tool absolutely sharp, however accurately it was ground, and if you took off just as much from the top of the tool as you took off the top of the thread, you had the bottom corresponding with the truncated top, and did away with the sharp V thread, which otherwise would have the objection which had been adverted to, and also the objection that it tended to weaken the bolt and render it liable to break under deflection. There was the most perfect contact which could be imagined. No one had a greater admiration for Sir Joseph Whitworth's work than he had, but scientific amateurs felt a difficulty in adopting his screw, because you could not curve off the top by any definite law, but had to make a tool which was different in its cutting radius for every screw. The thread proposed gave greater power, with an equal length, than the Whitworth, and Mr. Evans, and other eminent practical men held the opinion that the Whitworth thread was not fine enough for small screws or scientific work.

The CHAIRMAN said no one could complain of want of accuracy in the system Dr. Edmunds proposed, but when you came to practical working, it was a different matter, and he must confess that, until Dr. Edmunds enlightened him as to the particular pitch of the screws he had been using almost daily, for a great many years, he was in complete ignorance of the subject. He followed the course common amongst amateurs. When he wanted to fasten two things together, of employing a screw, he took the most suitable chasing tool for the purpose, which came to hand. Those who assumed something of a scientific character were very fond of accuracy, and no doubt they would all like to be theoretically perfect, if possible; but he had sometimes striven so long for accuracy that, in the end, he had thrown aside the work unfinished; so that even accuracy had its drawbacks. He was not in a position to say whether Molesworth or Dr. Edmunds was right about Whitworth's screws, but he could say that though they were admirable for the larger sizes, most people who used lathes would admit that they were not suitable for small threads. With regard to the new mandrel which had been shown, it looked a very nice tool, the diameter appeared to him rather large, but that was compensated for by the power of adapting small chucks and drills in the coned-out hollow inside. The ring at the base of the screw-thread reminded him of another device adopted in some ornamental lathes called an adapter, by means of which any ornamental chuck could be fixed with a certainty of its running true. Dr. Edmunds had referred to broken noses in lathes, but he believed there was a good deal of truth in what a friend of his said on the subject, that the fault generally lay in an imperfectly fitting chuck. He remembered on one occasion almost having an accident of this kind, through incautiously using a chasing tool, adapted for wood, to cut a thread in iron; he found the

chuck would not go on the lathe, and when he took it off, it stripped a small portion of the thread, and, most probably, if he had forced it on, it would have brought the nose of the mandrel off with it. As Secretary of the Amateur Mechanical Society, he must say that the resolutions quoted in the paper had not yet been passed, but were postponed to the annual meeting in May, when they would be considered by the society at large. He feared Dr. Edmunds was rather utopian in his ideas when he spoke of ornamental chucks being passed from hand to hand; he had three lathes in his workshop, and not one of the chucks belonging to any one of them would fit either of the others. He concluded by proposing a vote of thanks to Mr. Evans.

The vote of thanks was carried unanimously, and the meeting adjourned.

Correspondence.

IRON DRAIN-PIPES WITH LEAD JOINTS.

Upon reading Mr. B. H. Thwaite's remarks under the above heading, on page 242, it occurred to me that in his reference to iron railings fastened with lead, which had corroded away near the fastening, that he has not drawn any distinction between malleable-iron and cast-iron railings, as to their respective liability to said corrosion. I think the cast-iron railings are not so liable to be acted upon as the malleable, and, consequently, the lead-jointed cast-iron pipes will stand better than Mr. Thwaite imagines. So far as the action of general ordinary house sewage upon the interior of cast-iron pipes is concerned, I have seen such, after having been in use for many years, quite clear. While, supposing an iron pipe gets choked up, it is often not from rusting of the iron any more than a lead or stoneware pipe being choked in same circumstances. If the contact of lead with cast-iron pipes were to have the effect of causing the iron to get soon rusted away near the joint, many iron pipes would not have lasted as they have done.

W. P. Buchan.

21, Renfrew-street, Glasgow,
Feb. 3, 1883.

Town sewage does not appear to affect iron pipes with lead joints as much as ordinary water. A short time ago, I examined a number of iron pipes, 24 in. in diameter, forming the main outfall from Blackburn to the irrigation farms, and found them perfectly free from rust or corrosive action. These pipes have been laid about a dozen years. I have examined many iron pipes used for sewage, and in every case with the above result. The greasy matters appear to form a coating on the inside of the pipes, and thus to protect them. I have also examined water-pipes with lead joints forty years old, and have found them in perfect condition; and others, through which very soft moorland water, having an average hardness of only 2½ degrees, had been supplied, completely filled with rust after thirty years use. Lead joints are far superior to any others, and no one need fear the action Mr. B. H. Thwaite is apprehensive of.

William B. Bryan, M.Inst.C.E.

February 6th, 1883.

THE TECHNICAL ASPECTS OF LIGNIFICATION.

I regret much that I was unable to be present at Mr. Cross's lecture, the report of which I have read with great interest, as the subject discussed will, without doubt, have a most important influence on the future of our paper trade. Mr. Cross referred to me as originating the process of boiling under pressure with caustic soda, as applied to esparto; this is not correct, as none of my several patents specify high pressure, but the contrary; neither have I employed high pressure since the introduction of esparto to the trade in 1861, up to the present time, during which I have been treating from 120 to 160 tons of esparto weekly. Indeed, I do not consider that high pressure is required for the treatment of esparto or fibrous materials of a similar character; and although I am aware that high pressure is employed by some paper-makers, its advantages are very questionable, certainly as good results are obtainable by low or atmospheric pressure. The case is different with wood and other vegetable substances of several years' growth, which demand more energetic solvents, and more elevated temperature, only obtainable by high pressure. Mr. Cross referred to Tilghman's patent of 1866, as heating with sulphurous acid solution with or without a base, and at a pressure *not exceeding that of the atmosphere*. This is not quite correct, as, in the specification of that patent now before me, Tilghman claims "treating vegetable substances, which contain fibres, with a solution of sulphurous acid in water, either with or without the addition of sulphites, heated in a close vessel under pressure," &c., and, in the body of his patent, he specifies boiling in a closed vessel, heated by means of a steam-jacket, until the temperature of the liquid (sulphurous acid and sulphite of lime) is about 250° Fahr. (= 35 lbs. pressure). In 1867, Tilghman took out another patent, claiming the use of sulphurous acid in water under pressures not exceeding that of the atmosphere, stating that the addition of sulphite of lime, or magnesia, or soda, or other suitable base, so as to form an acid bi-sulphite, is advantageous. Both these patents of Tilghman's have expired, but a Frenchman, M. Lioud, took out a patent in 1877, for the treatment of woody and textile fibrous materials, with solutions of sulphurous acid, either alone, or, more or less, combined with different bases; and at a temperature, more or less, elevated

and prolonged. This patent, however, was allowed to lapse, assumedly finding he had been anticipated by Tilghman. Now we have Mitscherlich's patent, 1874; Francke's, October, 1881; Eckmann's, Nov., 1881; all claiming similar processes to the above, and we have, it would appear, to choose between these acid and the caustic soda processes, the latter patented by Houghton in 1857. We have excellent pulp made from wood by the caustic soda process, and it remains to be proved whether that produced by the acid process is equally good, and can be as readily produced with no drawbacks or disadvantages. Wood pulp will certainly extend in use as a paper-making material, seeing that esparto, on which we now mainly rely, maintains its price, and is likely to become dearer.

THOS. ROUTLEDGE.

Clanheugh, Sunderland,
February 6, 1883.

[Letters on "Sanitary Inspection of Houses," and "Suez Canal Statistics," are postponed till next week, for want of space in the present number.]

General Notes.

SUBMARINE COMMUNICATION BETWEEN CALABRIA AND SICILY.—It is reported that the arrangements for a tunnel under the sea between Calabria and Sicily are making rapid progress. (See *Journal*, vol. xxx, p. 366.) The Venetian Railway Company has finished its surveys, and the plans have been submitted to the Italian Ministry. The length of the tunnel is 13½ kilometres—8½ miles—and the cost is estimated at 71,000,000 lire—£2,840,000—including the 5,500,000 lire—£220,000—for the junction between the tunnel and the Messina station.

IRON CURTAIN FOR THEATRES.—Herr Hajek, of Aussig, constructs his fireproof curtain of corrugated sheet iron, and in two parts, divided horizontally. The portions are attached to the ends of two chains or iron wire ropes, one on each side of the stage, passing over grooved pulleys. The upper portion, which rises above the proscenium opening, is slightly heavier than the lower, which sinks below it, so as to facilitate the closing in case of danger; while in opening, the resistance to be overcome is only that due to the difference in weight between the two portions.

CORK EXHIBITION.—It is proposed to hold an Exhibition of Manufactures, Arts, Products, and Industries in Cork during the ensuing summer. The objects of the Exhibition are thus stated:—1. The exhibition of articles manufactured in Ireland and of raw materials—mineral, vegetable, and animal—produced in Ireland. 2. The exhibition of articles manufactered, and raw materials produced, in other countries which, in the opinion of the executive committee, may tend to the improvement of existing or to the development of new industries in Ireland. 3. The exhibition of machinery suited to Irish industries, the machinery manufactured in Ireland being distinguished from that of other countries. 4. An exhibition of paintings, sculptures, carvings, china, antique furniture, armour, antiquities, plate, lace, and other works of art. 5. A general loan collection of similar works and articles. 6. An exhibition of agricultural products and machinery, subject to the same conditions as are attached to exhibits in classes Nos. 1 and 2. 7. An exhibition of appliances used in the culture, capture, and curing of fish, both sea and river. The Exhibition will be utilised, as far as possible, as a school for educating the farming, artisan, and working classes, by means of suitable lectures, demonstrations, and reports. The Exhibition is to open in the first week in July, and to remain open for two months.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

FEBRUARY 14.—"The Society of Arts Patent Bill, and some points in American Patent-law and Practice bearing thereon." By SIR FREDERICK BRAMWELL, F.R.S. RICHARD E. WEBSTER, Q.C., will preside.

FEBRUARY 21.—"Recent Improvements in Agricultural Machinery." By D. PIDGEON. Sir FREDERICK BRAMWELL, F.R.S., will preside.

FEBRUARY 28.—"The Increasing Destruction of Life and Property by Fire. What is the Remedy?" By CORNELIUS WALFORD.

MARCH 7.—"The History of the Pianoforte." By A. J. HIPKINS. JOHN STAINER, M.A., Mus. Doc., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at 8 o'clock:—

FEBRUARY 27.—"Egypt, Present and to Come." By ROBERT W. FELKIN.

MARCH 20.—"Social and Commercial Aspects of New Zealand." By WILLIAM DELISLE HAY.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings at Eight o'clock:—

FEBRUARY 22.—"Some Causes of Fires and Methods for their Prevention." By WALTER G. MCMILLAN, F.C.S. Captain EYRE SHAW, C.B., Chief Officer, Metropolitan Fire Brigade, will preside.

MARCH 8.—"Self-purification of River Waters." By W. N. HARTLEY, F.R.S.E.

APRIL 12.—"The Formation of Diastase from Grain by Moulds." By R. W. ATKINSON, B.Sc.

APRIL 26.—"The Application of Electrolysis to Bleaching and Printing." By JAMES J. DOBBIE, D.Sc., and JOHN HUTCHINSON.

Indian Section.

Friday evenings at Eight o'clock :—

February 16.—"Overland Commercial Communication between India and China, *viâ* Assam." By Charles H. Lepper. Sir Rutherford Alcock, K.C.B., will preside.

March 2.—"Agriculture in Lower Bengal: with some Notice of Tenant Right, &c." By W. S. Seton-Karr.

April 16.—"Private Enterprise in India." By J. M. Maclean.

April 20.—"Fisheries of India." By Surgeon-General Francis Day.

May 4.—"Some Notes on the Domestic Architecture of India." By C. Purdon Clarke.

May 25.—

Cantor Lectures.

Monday evenings at Eight o'clock :—

Second Course, on "Solid and Liquid Illuminating Agents." By Leopold Field.

Lecture III.—February 12.

Colza, Olive, Whale, Sperm, and Fish oils. Mineral oils. Lamps :—The Argand, Moderator, Duplex, and Silber methods. Flashing points. Government restrictions.

Lecture IV.—February 19.

Secondary, or manufactured products. Chevreul's discoveries. Fatty acids; their formation by saponification, distillation, and pressure. Glycerine. Collateral benefits accruing from the Palm oil trade.

Lecture V.—February 26.

Paraffin. History and sources. Outlines of the chief processes of manufacture. Coal-tar products. Paraffin oil. Naphtha. Petroleum.

Lecture VI.—March 5.

Ozokerit, and other mineral sources of light. Manufacture of Candles. Survey of the candle trade and the various inventions and industries excited hereby. Conclusion.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 12...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Leopold Field, "Solid and Liquid Illuminating Agents." (Lecture III.)

Society of Engineers, 6, Westminster-chambers, S.W., 7½ p.m. Mr. A. T. Walmesley, "Land Surveying and Levelling." (Lecture V.)

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. B. Leigh Smith, "Second Voyage of the *Eira* to Franz Josef Land."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. T. G. Bonney, "River Valleys of English Lowlands: their Date and History."

Tuesday, Feb. 13...Royal Institution, Albemarle-street, W., 3 p.m. Professor W. C. Williamson, "Primæval Ancestors of Existing Vegetation." (Lecture V.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Thomas Bell Lightfoot, "The Design and Construction of Repairing Slipways for Ships."

Science Society, King's College, Strand, W.C. Mr. A. J. Spiller, "Instantaneous Photography."

Photographic, 5a, Pall-mall East, S.W., 8 p.m. Annual Meeting.

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. Mr. A. R. Colquhoun, "The Aboriginal and other Tribes of the Yünnan and the Shan Country."

Royal Colonial, the Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Mr. Parker Gilmore, "South Africa; the Territories Adjacent to the Kalahari Desert."

Wednesday, Feb. 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Sir Frederick Bramwell, F.R.S., "The Society of Arts Patent Bill, and Some Points in American Patent Law and Practice Bearing Thereon."

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m. Annual Meeting.

Royal Literary Fund, 10, John-street, Adelphi, W.C. 3 p.m.

Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Gulstonian Lectures.) Dr. J. M. Duncan, "Sterility in Women." (Lecture I.)

Thursday, Feb. 15...Royal, Burlington-house, W., 4 p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. G. Murray, "Outer Peridium of *Bromeia*." 2. Mr. J. G. Otto Tepper, "The Manna or Lerp Insect." 3. Mr. W. B. Hemsley, "Elongation of Pedicil of an Orchid after Flowering." 4. Mr. W. C. Ondaatje, "Ceylon Corals." 5. Mr. J. G. Baker, "Flora of Madagascar, III."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Special Meeting. Mr. W. H. Preece, "The Progress of Telegraphy."

Chemical, Burlington-house, W., 8 p.m. Mr. G. A. Perkin, "Some Derivatives of Diphenyleneketone Oxide."

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. C. A. Fyffe, "Europe since Napoleon's Fall."

Royal Institution, Albemarle-street, W., 3 p.m. Professor Dewar, "The Spectroscope and its Applications." (Lecture V.)

Royal Historical, 22, Albemarle-street, W., 8 p.m.

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. E. H. G. Brewster, "The Smoke Nuisance, and an Account of Some Improvements relating thereto."

Friday, Feb. 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. Charles H. Lepper, "Overland Communication between India and China *viâ* Assam."

Geological, Burlington-house, W., 1 p.m. Annual Meeting.

Royal United Service Institution, Whitehall-yard, 3 p.m. Captain N. L. Walford, R.A., "The Effects of the Bombardment of the Forts of Alexandria, and the Lessons to be learnt therefrom."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. William C. Williamson, "Some of the Anomalous Forms of Primæval Vegetation."

Philological, University College, W.C., 8 p.m.

Saturday, Feb. 17...Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. H. Stone, "Singing, Speaking, and Stammering." (Lecture I.)

Journal of the Society of Arts.

No. 1,578. Vol. XXXI.

FRIDAY, FEBRUARY 16, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C

NOTICES.

CANTOR LECTURES.

The third lecture of the course on "Solid and Liquid Illuminating Agents," was delivered by Mr. Leopold Field, F.C.S., on Monday evening, February 12th. The branch of the subject dealt with was the use of the various animal and mineral oils, and of different forms of lamps.

The lectures will be printed in the *Journal* during the summer recess.

OWEN JONES PRIZES FOR FURNITURE DESIGNS.

The Council are trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of the subscriptions to that fund, upon trust to expend the interest thereof in prizes to "Students of the Schools of Art, who in annual competition produced the best designs for household furniture, carpets, wall-papers and hangings, damasks, chintzes, &c., regulated by the principles laid down by Owen Jones;" the prizes to "consist of a bound copy of Owen Jones' 'Principles of Design,' a Bronze Medal, and such sums of money as the fund admits of."

The prizes will be awarded on the results of the Annual Competition of the Science and Art Department. Competing designs must be marked "In competition for the Owen Jones Prizes."

No candidate who has gained one of the above prizes can again take part in this competition.

The next award will be made in 1883, when six prizes are offered for competition, each prize to consist of a bound copy of Owen Jones' "Principles of Designs," and the Society's Bronze Medal.

H. Trueman Wood,
Secretary.

Proceedings of the Society.

FOREIGN AND COLONIAL SECTION.

Tuesday, February 6, 1883; Sir Donald Currie, K.C.M.G., M.P., in the chair.

The paper read was—

SOCIAL CONDITIONS AND PROSPECT OF MADAGASCAR.

By the Rev. J. Peill.

The visit of their Excellencies the Malagasy Ambassadors to England, and the sympathy manifested throughout the countr with them, and with the cause they represent, give an additional interest to an information about the large island of Madagascar at the present time. Much has been said and written, during the past few months, about Madagascar and its people, French claims on the island, &c., and much speculation has been rife as to the probable effects of French aggression. Into these speculations it is not our province to enter now: this paper has no political objects to serve. One result of the presence of these Malagasy gentlemen in our midst, however, has been to make the public aware of the existence of a people in the interior of Madagascar who are not barbarians, who are rising in the scale of civilisation, and are showing a willingness to welcome friendly help from more advanced nations which is almost unique among dark races. With increased knowledge has come increased sympathy with the Malagasy, in the noble efforts they are making to take their place among civilised and Christian nations. Most of what has been said and written about Madagascar, during the past few months, has had a more or less distinct bearing

on the present crisis; but, after all, the foreign relations of a nation during any particular epoch of its history is not nearly of so much importance as the social condition of its people, and the solutions being made, or attempted, of the many problems which arise among all communities whose life is not utterly stagnant.

The structure of Malagasy society is much more simple than that of more highly civilised nations. Many complex and intricate questions which arise amongst us are unknown to a more primitive and simple people like the Malagasy. Of some of the more important social questions which have arisen of late years, I shall have something to say presently. It should be remembered, at the outset, that most of what is said in this paper refers to the people who inhabit the interior of Madagascar. Of some of the coast tribes, and of the people of Southern Madagascar, very little is yet known.

The family is the germ of the tribe, and the tribe of the nation; in order, therefore, to understand the condition of a people, something must be known of their family life. The houses of the Malagasy are of very simple construction, being in the interior provinces built of the hard red clayey soil of the country, and roofed with grass or rushes; on the coast and near the forest, chiefly of wood or reeds. These houses are small, and, in most cases, consist of a single room used for all purposes, with earthen floor; the floor is covered with plaited rush mats. There is no chimney to admit of the exit of the smoke. There are one or two small unglazed windows, and a single door. In the greater part of Imerina, the pigs and fowls occupy one corner of the house at night, and go freely in and out during the day. Owing to the mildness of the climate, the people spend much of their time in the open air. There are, in most of the important villages of Imerina, one or more large wooden houses of a more pretentious character than those described above; these belong, in most cases, to the lord of the manor, and have been erected by the people for them by unpaid labour. In the capital these large wooden houses are oftener to be met with than in other towns, while the top of the hill on which the city is built is crowned by an immense wooden palace, the design and execution of which certainly do great credit to the Malagasy carpenters who built it. Of course, in Antananarivo, and in other towns where the effects of European teaching are most apparent, a great change has passed over the dwellings of the people as over themselves. The capital has been almost entirely rebuilt during the last twelve years, many of the houses being erected according to European plans, built of brick, and roofed with tiles. The most prominent objects in the capital are the numerous stone churches, the new college buildings, the prime minister's palatial residence, and the great palace before referred to, now surrounded by a three storied granite balcony.

In many villages of the interior, good houses on European models are taking the place of the native huts, as is also the case in some towns on the coast. And even where large houses, with many rooms, are not attempted, an effort is made to get at least two rooms and some furniture of extra-Malagasy origin, tables and chairs having been unknown luxuries before the advent of Europeans. The wants of the people are few, their land is wide, rice is cheap and abundant, and this is their staple food. Clothing, to the common people, is not an expensive item; the *lamba* is their chief article of dress; and as American calico is imported in immense quantities, and sold at a very cheap rate in the markets, this can be readily obtained. To those who, in increasing numbers, are adopting the European dress and style of living, life is becoming a much more complex thing; with the comforts and conveniencies of civilisation come also its cares, and its increased activity and industry.

The family does not consist of the parents and children alone; for, as marriage is entered upon at an early age, frequently the wives of the sons live in the parental home. Slaves have their own houses, but some usually live with the family, enjoying certain rights and privileges as inferior members of it.

With the additional element of slavery, the people are divided into two classes, like ourselves, nobles and commoners. The nobles again are separated into six sub-divisions, which, with some exceptions, may not intermarry. Only members of the three upper divisions of nobles can hold the position of feudal barons or chiefs over the districts once ruled as kingdoms by their ancestors. The lower order of nobles, with the exception of certain privileges and titles of respect, are pretty much on a level with the commoners, though not permitted to intermarry with them.

The commoners, again, are split up into endless tribal divisions. The people of Imerina, that is, the Hova people, or ruling race of

Madagascar, are separated into six main divisions, occupying the six portions into which the province is divided. The various tribes, both of nobles and of commoners, are very conservative of their rights; and families, in order to keep their property among themselves, encourage the marriage of near relations. The sovereign may marry a commoner; the present illustrious husband of the queen of Madagascar is a commoner by birth. With the consent of the heads of the families and of the tribes, and with the sanction of the sovereign, members of different tribes may intermarry; but this consent is very difficult to obtain, and so such marriages rarely take place.

The native marriage ceremony is of a simple character; and although the Deity is invoked, and his blessing asked upon the couple, there does not appear to have been any religious significance attached to the ordinance. It is a civil contract, entered into publicly by the two parties, in presence of the members of the two families, and their relatives and friends, gathered together to witness the proceedings. A present of money is always given to the bride's parents by the bridegroom, which is called the "sheep's rump," doubtless in allusion to a former custom now extinct. Without this present, given in presence of witnesses, the marriage is not binding. If the contracting parties are commoners, the bridegroom, accompanied by his relatives and friends, proceeds to the house of the bride's father, where all her family are assembled with the heads of the people. When the speechmaking is over, and the present made, they partake of a feast provided for them, and then the bridal party proceeds to the house of the bridegroom's parents, where they are welcomed with feasting and rejoicing, after which the bride and bridegroom are led once round the house outside, and thus the ceremonies are completed. If the parties are noble, the bridegroom does not go in person to fetch his bride, but awaits her coming in his own or his father's house.

The marriage relation had not, until recently, among the Malagasy, the sanctity or permanency which it possesses among more civilised nations. Many Malagasy proverbs state clearly enough what were the prevalent views with regard to it. "Marriage is not tied with a knot but with a bow" (and so easily undone). "Buying and selling is like marriage, if you don't agree you can separate." "Separation by death is a calamity"—implying that separation while still living is not so. A wish frequently expressed to a newly married couple was: "May you not be parted by death, but separated whilst living."

Divorce was very frequent and easily obtainable, the right to exercise it resting with the husband alone. At any time, for no offence, or on the slightest provocation, he had but to say to his wife, "I thank you," in the hearing of witnesses, and the marriage bow was untied. Christian teaching and example have effected a great change in this respect. In the new code of laws promulgated in March, 1881, it is enacted that no marriage will henceforth be considered legal which has not been duly registered by the State officials, and no divorce will be considered valid that has not received the formal consent of the appointed authorities. Under this new code, if a man and his wife separate without having first had the matter tried before the authorities, and received their sanction to such separation, they are liable to a fine of fifty dollars, the man paying two-thirds of that sum and the woman the other third. It is understood that, except for adultery, no marriage will be disannulled by the State. Marriage is frequently entered upon at a very early age. Many of the scholars in our schools, little boys and girls, are already married, and babies newly born are sometimes betrothed by their parents. Until quite recently, marriages were arranged by the parents or the heads of the families, no account being taken of the personal likes or dislikes of the children themselves; but it is becoming much more customary now to allow freedom of choice within certain limits, and, at any rate, to give the young people the power to refuse any proposed match if they have a strong antipathy to it.

Polygamy was a recognised custom among the Hova not many years ago, as, indeed, in the greater part of Madagascar it is to this day. In Madagascar, as in all countries where polygamy is practised, the great mass of the people were monogamists, the rich and powerful among them alone actually possessing a plurality of wives. Owing to the frequent wars carried on by the Hova with other tribes, and the consequent heavy annual loss of men, there must have been formerly a considerable surplus of women over the male population. The Malagasy did not escape the evils usually attendant upon this institution, as the name they applied to any wife except the first clearly implies; she was called "rafy," or adversary, and a man who took more wives

than one was said to "mamporafy," that is, literally translated, "cause to be adversaries," no doubt on account of the family quarrels inseparable from the practice. The early kings of Imerina were supposed to have twelve wives each, while among the Bara people a chief may have any number. One of their kings, called Ivoatra, is said "to possess wives counted by the hundred;" while every petty kinglet or chief has from four to twenty or more. In 1881, polygamy, which had often before, in a semi-private way, been denounced by the authorities of Imerina, was declared in a public proclamation to be henceforth illegal, a fine of ten head of cattle and ten dollars being threatened against any one who should be found guilty of the practice.

The Malagasy were, previously to the introduction of Christianity, a very licentious people. There appears to have been no very strict code of morality existing among them. On certain occasions, indeed, all restrictions were removed for a time, and general license granted. Among the Bara tribe of Southern Madagascar, which is still heathen, a very sad state of things is said to exist, "purity and chastity being unknown." Of them, the Rev. J. Richardson writes:—"In speech and manner they are rough and filthy in the extreme. The men, the women, the boys, and the girls know no shame; our purity of speech was laughed at and pitied." A great change has passed over the Hova in this respect in recent years, and a very much higher standard of morality has taken the place of the old looseness and immorality. A very marked improvement is visible in consequence, and an enlightened public opinion is growing rapidly, which is a great aid to yet further advancement. Christianity, with its high, pure code of morality, is gradually elevating the people in this respect, and will doubtless continue to do so.

A very interesting trait of Malagasy character is their intense love for children. Parents love their offspring with an ardent affection, and no better wish can be expressed for any one, than that they should be blessed of God with many sons and daughters. The struggle for life is not so keen in a country like Madagascar as in countries where an old civilisation exists, and which are more densely populated. The land is broad, and in many parts but thinly peopled, so that an increase in the number of inhabitants is an unmixed good. By a Malagasy, what the Psalmist said of children is readily accepted: "Happy is the man that hath his quiver full of them; they shall not be ashamed, but they shall speak with the enemies in the gate." This parental affection is generally repaid by the children when their parents are aged and infirm.

Notwithstanding all this, however, infanticide was common among the Hova in heathen times, as it is still among some of the tribes. It does not appear to have been with the Malagasy as with the ancient Romans, the absolute right of the father over the life of his offspring that originated this cruel custom; and its existence was no proof of loss or paucity of affection on the part of the parent, but rather a sign of the power exercised by superstition over the minds of the people. Natural affection, however strong, is no match for superstitious fears. The early days of one month in the year were considered especially unlucky, and children born at that time were usually put to death. The face of the new-born infant was turned downwards into a shallow wooden bowl, full of water, and held there until suffocation ensued. Sometimes an infant was given the chance of life by being placed in the way of the cattle as they were being driven into the village through a narrow gateway, at sunset. If the child escaped being trodden to death under the hoofs of the inrushing cattle, which did occasionally happen, it was supposed to have overcome its evil destiny, and was permitted to live. If a slave, it was immediately set free. These and other cruel customs have died out in the central provinces, as a result of Christian teaching, but among the Bara people infanticide is still commonly practiced. "If a child is born on a day unlucky to the father only, its life is spared for the mother's sake; if on a day unlucky to the mother only, the child is spared for the father's sake; if on a day fatal to both, it is buried alive in an ant-hill."*

The status of the child is conditioned by that of the mother; thus, if the mother be a noble, her children belong to the same order of nobles as herself, whatever the rank of the father may be. I may mention here, in passing, that the rite of circumcision is practised by the Malagasy. The rite is performed in presence of a large assembly gathered to witness the ceremony, and take part in the family rejoicings on the occasion.

The fact of the Malagasy sovereigns since 1828—with but a single brief exception—having been women, itself speaks for the position of women among them. While

* Rev. J. Richardson.

women in India and in Mohammedan countries are shut up in zenanas and harems, and in China are so much despised that female children are frequently destroyed in infancy, it is very different with their more highly favoured Malagasy sisters. True, the most welcome salutation you can give to a parent on the birth of a child is in the words of one of their proverbs, "You desired a child, and a son is born to you." Yet if the infant be a girl, the little stranger is welcomed almost as warmly as if it had been a boy. Among some of the African tribes, the women are mere slaves of the men; they dig the fields, they carry the burdens, they do the manual labour while their lords and masters hunt, fish, fight, &c. Among the Bara tribe in Madagascar a similar state of things appears to exist. The following quotation from a translation of a short account of the Bara tribe, furnished to the editor of the "Antananarivo Annual" by a native, will suffice to show this:—"When a husband is eating his meals, his wife is not allowed to join him, nor even to look at her husband while thus engaged. The condition of these Bara wives is truly pitiable, for the husband will do no manner of work; he will neither fetch in firewood, nor work in the rice fields, nor fetch water, nor pound rice, nor even feed the fire. The only things the men do are fighting and tending cattle. If a wife leaves her husband, frequently she is shot by her father as being unfit to live. If husband and wife separate, no portion whatever of the goods falls to the lot of the wife." In striking contrast with this is the position of the Hova women. On special occasions, as during the transplanting of the young rice, at the commencement of the rainy season, the women and girls turn out into the fields to do their share of the work, just as during hay time or harvest is the case in many parts of England; but the men dig the fields, break the clods by driving the cattle over them, or with the spade, sow and reap the rice. The woman's place is, as a rule, at home, where she cooks the food, looks after the children, fetches the water for the household, plaits mats, or with her long tapering fingers spins and weaves in cotton and silk. The wife, when she possesses any property, holds it by her own right, and in case of separation from her husband, can claim one-third of the household goods in addition. Women often hold the position of feudal chiefs, and exercise their rights as such quite independently of their husbands. The women and girls enjoy perfect freedom. The girls attend our schools along with the boys, and have the same rights and privileges with them. Both sexes attend public assemblies, and worship freely in our congregations. The girls are bright and intelligent, and take quite as good positions as the boys in their classes at school. Among the older people in country places there is often a marked difference in intelligence between the men and women, but this may be partially accounted for by the fact that the men took part in the trading, fighting, and management of local and tribal affairs, by which their wits were considerably sharpened, and thus they had the advantage over the women; and then the frequency of polygamy, the looseness of the marriage tie, and the low state of morality among the people, while evil enough in its effects upon the men, was doubly debasing to the women. Christianity in Madagascar is elevating woman, purifying her, and making her more truly the companion and equal of the man.

The Malagasy are very respectful to their superiors in rank, wisdom, or age. Indeed, this respect frequently degenerates into servility as regards superiors in rank. To the sovereign, formerly divine honours were paid; he or she was spoken of as the "visible deity." The most extravagant epithets are even yet applied to her. The whole island is frequently said to be her eyes and ears. Comparing her to fire, one of their proverbs says:—"If you are too far from her, you are cold; if you are too near her, you are scorched." Occasionally an old chieftain, who still remembers the former days and forgets the changes that have intervened, brandishing his spear, will apostrophise her majesty as "lord of heaven and earth!" Even the queen's waterpots, carried by her slaves from the well, must be made way for in the most crowded thoroughfare, every hat being removed as they are borne past. You meet some men carrying baskets on their heads, or slung on a pole over the shoulder, and a man strutting in front armed with a spear crying out, "clear the way, clear the way;" immediately the bearers of your palanquin step off the road, reverently uncover their heads, and wait until the queen's baggage has passed. When a sovereign or noble dies he is euphemistically said to have "turned his back."

White men, of whatever nation, who conduct themselves at all decently, receive the greatest kindness and respect. The Hovas are fully aware of the advantages which

they have reaped from their connection with Europeans, and are willing to receive further instruction from them. There are many Europeans and Americans who can bear witness to the generous hospitality and genuine kindliness of the Malagasy character. Politeness to strangers is indeed a national characteristic; in every Malagasy house the north side of the fireplace is reserved as a place of honour for strangers. In their mutual intercourse, too, even amongst the poorest of the people, an amount of ceremony and politeness prevails which is novel and striking to a European.

Great respect is paid by the Malagasy to the memory of their deceased ancestors. Formerly divine honours were paid to them, presents offered at their tombs, and their blessing invoked on all occasions. There was evidently a belief very firmly rooted in the minds of the people in the existence of the spirit after death, and in the power of these spirits to influence for good or ill the affairs of men. The spirits of the dead were believed to inhabit the tombs, and hence we find a lavish expenditure on tombs. A man will dress in the coarsest material while living, work hard all his life, and be contented to occupy a miserable hut, that at his decease he may be wrapped in silk, and laid in a hewn stone sepulchre. So costly are these tombs, and yet so necessary are they esteemed, that among country people in making marriage arrangements, a woman is thought to have made a good match if her husband's family tomb is completed, and yet he has a little money in hand. If, on account of the tomb not yet being completed, or for any other cause, a person is buried elsewhere, on the completion of the tomb, or about a year after burial, the body is exhumed, the bones are wrapped in a new red silk *lamba*, and then, amid general rejoicing, removed to the family tomb. Sometimes bodies are taken out of the tomb to be re-wrapped in *lamba*, and then returned to their place again. On these occasions all friends and connections of the family are invited; they appear at the appointed time, decked out in their best attire, or, as frequently happens, in clothes hired for the occasion; there is a sound of revelry, drums are beaten, a band plays, bullocks are killed, and feasting, dancing, singing, and rejoicing are the order of the day. In the dry season, when there is not much work to be done in the fields, these scenes are of frequent occurrence, and are a source of entertainment to the people, relieving the humdrum monotony of their everyday life.

The people are very sympathetic, and mutually helpful in time of sickness. One of their proverbs, frequently quoted, says, "The sick are nobles." If a person is ill, his relatives and friends come to visit him, to condole with him, and attend to his wants. As the sickness increases in severity, the house becomes crowded with sympathising friends, and immediately life is extinct, a chorus of lamentation, peculiar to Eastern peoples, breaks forth. The women let down their long hair about their necks and shoulders, and keep up a continuous wailing. Friends do all that is needful for the dead, never leaving the body, night or day, until after its interment. Those who desire to show sympathy, bring a present to the chief mourner, which is called "fao-drauomaso," or, a tear-wiper. To quote from a native account, "Death is the greatest of all misfortunes. Every one on this occasion brings a small piece of money, some furnish the rice for the friends that assemble, others bring fowls, sheep, or even an ox. Every one does his best to help the bereaved person, who can thus remain quietly alone to mourn. Some prepare the body for burial, others carry it to be buried, others open the tomb, while some remain to console the friends of the dead. Every one, in fact, brings of what he has, and does what he can to assist his fellow-countryman in distress." This shows how much neighbourly feeling exists, manifesting itself especially in times of affliction and death.

The various clans among the Hova, at the end of the last century, each had its petty chief, dignified by the title of king. Through the multiplicity of these kings, internecine war was constantly going on, cattle-lifting raids were frequent, one clan fought against another clan, one chief against another. Andrian-imporaimerina was the first king of the Hova, properly so-called. In his days, and during the lifetime of his son, Radama I., the various clans were compelled to acknowledge one sovereign, and were thus formed into a compact nation. The local kings who submitted of their own accord were granted certain rights, and were still regarded as the heads of their respective clans. Those who were defeated, or fled, were replaced by favourites of the king, or their kingdoms were confiscated to the crown. The descendants of these kings still retain many of the privileges granted to their forefathers. The people of their own

districts render fealty to them, they can exact personal service from their subjects, and hold a position in many respects similar to that of our old feudal barons. They act as magistrates in their own districts, arrange petty disputes and quarrels that arise among the people, but send up graver cases to the capital, to be tried in the regular courts. A spade tax is annually levied throughout Imerina, which is paid in rice. In one district, the rice brought in, in payment of this tax, by the spade owners, after being collected together, was divided thus :—One third went to the chief residing in the village, another third was sent to the head of the family residing in the capital, while the remaining third was the portion of the Sovereign. In other districts a similar arrangement exists, the quantities received by each varying in different districts.

The Government of Madagascar is autocratic, all authority is centred in the Crown, the people, chiefs included, frequently speak of themselves as slaves of the Sovereign. A Malagasy would never speak of his house as his castle, the idea is utterly foreign to him, he would call it "tranon' Andriana"—"the Queen's house." The sovereign is declared in all public official documents to reign by the grace of God and the will of the people.

In their relation to the Government, the people are divided into soldiers and civilians. Each of these classes renders Government service, but of different kinds. Military service is compulsory, and until recently was for an unlimited period. The soldiers receive no pay, rations, or pensions, only their uniform and guns being provided. In 1879, a new conscription was made, and a new and much milder system introduced. Many of the old soldiers were set free, and the rest were promised that they should be freed after three years' further service. A system of short service was introduced. According to the present plan, all able-bodied men, without distinction of class or rank, are liable to military service for a period not exceeding five years. Ten thousand men are to be taken up annually, and after five years, ten thousand each year will be drafted into the reserve. Instead of being forced to go up to the capital at stated periods for drill, as under the old system, the soldiers are now drilled in their own districts by qualified officers appointed for the purpose. The garrisons on the coast are to be relieved annually. Until these new regulations came in force, it was considered a great calamity to be a soldier. The common soldiers, on account of the hardness and amount of service required of them by the Government, were considered worse off than the slaves, while they were always liable to be sent to distant and unhealthy parts of the island for an indefinite period of time, where great numbers died of malarial fever.

The civilians are divided into hundreds and thousands, each with its headman; over these again are heads of three thousand, heads of five thousand, and so on. Thus a very elaborate system of local organisation exists. When the people are required to assemble for any purpose, the chief sends for the headmen of his district, they call up their subordinates, while these again, through the minor officials, communicate with the people scattered over the country in the various villages and hamlets. The people inhabiting the mena-be or crown lands have a similar organisation with the exception of the local chief, the sovereign in this case dealing directly through her representatives with the heads of the people.

It will thus be seen that the difference between the social life of the Malagasy and that of our own people is very great. They have no elective institutions, no corporations, or local boards, no money-rates, or taxes. The people do not originate reforms, or discuss politics. All advancement and reform comes from above downwards; not, as is often the case with us, from below upward. This com plete system of organisation has a tendency to repress individuality. There is a lack of spontanity and local public spirit. Looking always towards their superiors, the people originate nothing; they depend on the centurions, the centurions upon the heads of thousands, they again upon the chiefs, and the chiefs upon the sovereign. Everything is cramped by over-centralisation—at least, so it appears to an Englishman. Sir Charles Dilke, in one of his recent speeches, told an amusing story illustrative of the evils of ultra-centralisation in India. He said, "A distinguished friend of mine, who went out to India in a high capacity, almost immediately upon his arrival received a telegram from a railway station, which was also a police-station, and the residence of a magistrate, about 220 miles up country, and which ran as follows: 'Tiger jumping about on the platform. Please telegraph instructions.'"

Now this was, doubtless, a very extreme case; but it seemed to me, as I read it that, in some degree, the Malagasy suffer from the same thing. A tree may fall across the main road

from the coast to the capital; hundreds of people will lift their loads over it, or twist themselves into trying attitudes to get under it, or go round about to escape it, but no one will think of removing the obstruction, unless orders come from "above" that it must be removed.

The system of "fanompoana," or unpaid Government service, is still in force, and is the "service" of our feudal times. Every one is liable to an undefined amount of unpaid personal service, and this not only directly to the Government, but to his chiefs and superiors as well. Those who show any special skill suffer most from this arrangement, because the more ability a man displays in any line, the more useful he becomes to his superiors. I have before referred to military service; that of the civilian consists of fetching wood from the forest, making bricks, building houses for his superiors, or the Government, &c. For all this there is no remuneration given, except, perhaps, some food occasionally during the progress of the work. The system is not so severe as it formerly was, and is being gradually modified; but it is evil in itself, acts as a deterrent to progress, and the sooner regular taxation, which can be equally distributed, shall take its place, the better.

Among the Malagasy, as amongst most people, there are traditions of a golden age in the past. It is said that before Europeans came among them, theft was an unknown thing. Anything of value might be left in the market, or on the public highway, for weeks, and its owner, on his return to the spot, would find it still where he had left it. Until quite recently, lynch law was exercised upon thieves. Anyone guilty of stealing in the market might be set upon by the mob, and beaten or stoned to death on the spot. On one occasion, when house-breaking had been more frequent than usual in the town in which I lived, one evening the town-crier called all the inhabitants together, and there, in solemn conclave assembled, they all bound themselves to keep the peace. In order to ratify this agreement, each householder paid a small sum of money, and with the total amount thus contributed, several oxen were bought. When the oxen had been killed, and the flesh distributed among the people, a pole was stuck up at each entrance to the town, and on the top of these poles the horns of the oxen were fixed. There they remained for a long time, a standing witness to the agreement entered into, which was faithfully carried out.

There are some questions of a more general character affecting the social condition of the Malagasy, which, in a paper like this, it is impossible for me to ignore. It has been stated, in an earlier part of this paper, that slavery still exists among the Malagasy. The slave population forms the third of the great classes into which the people are divided. While, in its essential character, slavery is the same wherever it exists, yet in Madagascar its evils are considerably modified by the absence of colour prejudice. The slaves and their masters are of the same colour and of the same race. The system, as it exists among the Malagasy, is of a patriarchal character, the slaves being inferior members of their master's family. Until the year 1877 Madagascar was one of the principal marts of the East African slave trade. Great numbers of Africans, kidnapped by the Arabs, were shipped to the Madagascar ports, where they were readily and profitably disposed of. In the Anglo-Malagasy Treaty of 1865, a clause against this foreign slave trade was inserted, and efforts were made by the Government to carry it out; but in many parts of the island they were unable to do this, and there can be little doubt that some of their own officials were implicated in this illicit traffic. Anyhow, it is quite certain that great numbers of African slaves were imported into Madagascar, in spite of the treaty, and of all the efforts of our men-of-war to prevent it. In October, 1874, the queen issued a proclamation, setting free all African slaves imported since the treaty of 1865. And when this failed of the desired effect, on the 20th June, 1877, she issued a further proclamation, setting free all African slaves in the island. This latter proclamation was printed and scattered broadcast over the land. The effect was what might have been expected; from that time, foreign slavery was finally put a stop to in all parts of the island to which the authority of the queen extended. Were her authority more firmly established throughout the island, there is no doubt that the iniquitous traffic would be utterly abolished in all parts of Madagascar.

Domestic slavery still exists, and probably will yet survive for some time. Slaves are, on the whole, treated kindly, but the evils inherent in the system remain. Most Malagasy slaves are descendants of captives taken by the Hovas, in the many wars waged by them in former years against other tribes. These wars were most mercilessly cruel; the men defeated in battle, if unable to escape, were massacred, while the women and children were carried off

to Imerina, where they were sold as slaves. The descendants of these captives, with those of Hova formerly reduced to slavery on account of debt or criminal offences, form the slave population of Imerina. They are divided into various classes, which, as a rule, do not intermarry. The slaves of chiefs hold a superior position to those of commoners. The descendants of Hova, who are now slaves, keep themselves distinct from the other classes, whom they regard as their inferiors. In the country, slaves possess their own rice grounds, which they cultivate for their own and their family's benefit. In Antananarivo this is not so much the case, rice ground being more expensive, and there being many other ways of making money. Slaves enjoy considerable freedom of action; while theoretically without rights, practically they enjoy a good many. As there are no made roads and no wheeled vehicles in Madagascar, travellers are carried in palanquins, and baggage is conveyed by men. Slaves are permitted by their masters to hire themselves out as servants and labourers, to carry baggage and messages to and from the coast, to go on long journeys with travellers, in fact, to do anything for which they can obtain wages. Sometimes the master receives a portion of the wages thus earned by his slaves; sometimes he receives nothing at all, but in that case the slave has frequently to hire someone else to take his place, and fulfil his share of personal service when required; sometimes the master is hard and grasping, and demands all; let us hope he seldom gets it, which I believe is the case. Some of the slaves show considerable spirit in dealing with their masters, and when they are unjustly treated, either induce someone else to buy them, or flee to a distant part of the country out of their reach. Slaves are not unfrequently slaveholders themselves.

But while on the whole the system is of a mild character, as compared with the slavery so recently abolished in the Southern States of America, yet cases of cruel oppression are not uncommon. The slaves are at the mercy of their masters—they have no recognised rights; it is inevitable, therefore, that frequently they should be cruelly wronged. The whole system is repugnant to Christian ideas of what is right between man and man; while, of course, the existence of a large slave population inevitably tends to degrade labour, and to encourge laziness.

The better spirits among the Malagasy are beginning to realise that the system is iniquitous, and is inconsistent with their Christian profession. Not long before I left the island, one of the most enlightened of the Malagasy, himself a slaveholder, and a Christian pastor, said:—"Slavery is the one thing still remaining which hinders us Malagasy from being a really Christian people. Our consciences will never be able to rest any more on this question." So keenly sensitive on this subject, indeed, is the public conscience becoming, that in Antananarivo it is unwise to make public reference to it.

Some steps have recently been taken with a view to modifying the evils of the system. In the new code of laws, already mentioned, promulgated on March 29th, 1881, it was enacted that, slaves from Imerina may no longer be carried off and sold away on the coast far from their friends; and also that slaves may not be traded in as merchandise. If a man wants a slave to keep for his own use, he may buy, and the former master may sell, but the transaction must be between the two persons themselves, not through slave-dealers, and must be duly registered by a government official, otherwise it is not a legal purchase. One of these new laws declares it to be a crime of the gravest character to export slaves from Madagascar, or to import foreign slaves; the penalty attached to this is chains for life, and the confiscation of all the property of the offender. Some years ago, it was declared illegal for a young slave child to be sold away from its mother.

It will, doubtless, be many years before slavery is finally abolished in Madagascar. Those who desire to see that day, rejoice that foreign slavery is now a thing of the past, and that some attempt has been made to modify the evil of domestic slavery, and they hope that they have already witnessed the beginning of the end. The religion which teaches the Fatherhood of God, and the brotherhood of all men, is in Madagascar, as it has done elsewhere, undermining the very foundations of slavery.

A few words must be said on the rum question; for it is one of the social problems of Madagascar, and a difficult one. All the tribes of Malagasy appear to understand how to distil spirit. Rum is distilled from the fruit of a certain palm tree by the Sakalava. It is also obtained from honey and the sugar-cane. That it is freely drunk among all the tribes, there can be no doubt whatever. The Sakalava are said to give it even to infants at the breast, while one

of the missionaries who travelled in their country says he has seen children stagger in their play from its effects. The Hova government has again and again prohibited the manufacture and sale of rum within a certain radius of the capital. Drunkenness within the prescribed limits is rarely seen, but immediately one gets outside these limits, especially going eastwards towards the coast, a very different state of things is found to exist. Rum from Mauritius is poured into Madagascar in immense quantities annually. From a pamphlet recently written, by Mr. Shaw, a missionary residing in Tamatave, I learn that, from Mauritius alone, in 1881, 10,087 barrels of rum, containing 462,915 gallons, were landed on the east coast of Madagascar, and in Nosi-be. This imported rum is retailed in Tamatave at the low price of 6d. per quart. Some of this rum reaches the capital, carried there by British and French merchants, in spite of the strong prohibitive laws, which they contend do not apply to them. While in all the villages on the road to the east coast from Antananarivo, beyond the limits already mentioned, tapped casks may be seen standing in the doorways of the native houses, and natives freely partaking of the fiery liquid. So terrible a curse has this cheap foreign spirit become on the east coast of Madagascar, that all progress is prevented by it; it is destroying the natives, and gradually depopulating the country.

The native Government wishes to prohibit the sale of this rum; it sees the desolating effects of the traffic, and prefers not to have the money received as Custom dues from its importation; but foreigners, many of them British subjects, press the trade, and in so doing, shelter themselves behind their treaty rights. Formerly the Government, finding itself unable to prevent the importation of rum, owing to existing treaties with England and France, but resolved not to profit by it, used to publicly pour out on the beach the contents of the barrels taken as Custom dues, as a protest against its introduction. Quite recently, the first use they put their newly-acquired vessel, the *Antananarivo*, to, was to carry back to the Mauritius, to be sold there, the rum taken on their own coast as Custom dues. If the native Government were at liberty to raise the duty on this article, so as to prevent its being sold at so cheap a rate, this would, doubtless, act as a check upon its consumption. Hitherto, owing to the terms of the Anglo-Malagasy treaty, they have been prevented from doing this. It is earnestly to be desired by all friends of the Malagasy people that, in the revised treaty now under the consideration of our Government, full liberty will be allowed to the native Government in this respect.

The land question is one of considerable importance at the present time. All along the Malagasy have steadily refused to sell land to foreigners, and although land may be leased for a term of years, yet so many difficulties have been put in the way, and such short terms granted, that it has long been a standing grievance. There will have to be a change soon in this respect. Indeed, no one sees this more clearly than do the Malagasy themselves; and in a revised treaty, recently negociated by the American Consul at Tamatave with the native authorities in Antananarivo, and at the present time awaiting the ratification of the American Government, much has been conceded. One clause of that treaty provides that land may be leased to American citizens for terms of 25 years, the lease being renewable indefinitely. What the Americans have already obtained other nations may also claim, and thus many of the hardships justly complained of will be removed.

Among the Hova themselves a commoner obtains possession of land either by gift or purchase. The people amongst whom the land is already divided are regarded as owners, with power to give or sell. Anyone obtaining fresh lands, must undertake all the responsibilities connected therewith, and be subject to the customs which prevail in the divisions of the country in which the land is situated, as well as pay his share of the annual rice tax to the local chief or sovereign. Once in possession of land, obtained as above, no Malagasy subject can be deprived of his rights by anybody's caprice or arbitrary power; while on the other hand, he is bound to fulfil strictly the conditions under which he holds the land. He may wish to reside elsewhere, and may obtain another piece of land, but he must still continue to pay the tax and discharge the duties connected with his former location. All unreclaimed lands are divided amongst the six great divisions of Imerina. These may be cultivated at will, by anybody; but a person intending to take up his abode on land of this kind, must apply to the heads of the division to which the soil belongs. According to the newly promulgated laws, to which reference has again and again been made in this paper, foreigners must regard unreclaimed lands as belonging to the queen.

Education is making rapid strides among the Hova and Betsileo tribes; it is also spreading among the Sihanaka to the north, the Betsinisaraka on the east, and, in a less degree, among the Sakalava on the north-west of the island. When we remember that sixty years ago the Malagasy were barbarians, without a written language, worshipping idols —and then remember that to-day they possess a written language, with a considerable and increasing literature, printing presses worked by native printers, more than 1,000 elementary schools in active operation, and that at least 60,000 Malagasy are able to read—we begin to realise the great change that has passed over the people in a very limited period of time. At the present time, education in Madagascar is compulsory, every child of free parents of eight years of age and upwards being required to attend school. Standards of examination have been prepared, and no child is to be freed from attendance at school until he has received a certificate from the Government inspector, stating that he has passed the prescribed examinations, or has reached the age of sixteen years. Parents or guardians who will not send their children to school, and lazy or unfaithful teachers, are liable to fines, or, in default thereof, a short imprisonment. These laws, if duly enforced, will, in the next sixty years, work yet greater changes than have taken place in the past. As the intelligence of the people increases, many old superstitious notions, which still stand in the way of progress, will be removed. In the central provinces of Madagascar, Christianity has taken the place of idolatry, progress of stagnation. Many crudities and anomalies still exist. These will pass away as the people become more enlightened, and more fully accept the civilisation that has been brought to them by the white man. As there is an abundance of iron in the country, and the supply of valuable wood in the forests is practically unlimited, there is no reason why, as the people grow stronger and less afraid of foreign aggression, railways should not be made from the coast to the capital, thus greatly facilitating trade with other countries.

In the centre of the large island of Madagascar, there is thus a small nation, the ruling race of the island, which has put aside many of its old superstitions, and thrown itself open to Western ideas. Its idols have been burnt. It has accepted Christianity, both in the person of its sovereign and as the national faith. It has a firmly established and enlightened Government at its head, leading it forwards in the paths of progress. It has already mounted the first few rungs of the ladder of civilisation, and is diligently urging forward the education of its children. All around this central power are other tribes, less enlightened, but coming more and more under its influence. Will it be permitted by stronger and more civilised nations to work out its own future unmolested, and to send out the light, hitherto focussed in itself, to those around it still in darkness, while itself receiving yet more and more? If let alone, this, so far as we can see, is to be the future of the Hova race. Will it be permitted to work out its own destiny without interference? We most sincerely hope it will. Instead of being threatened and interrupted by stronger and more advanced nations, it has every claim upon them for help, advice, and encouragement.

I have hitherto refrained from discussing present Franco-Malagasy difficulties, but since the social prospects of the Malagasy people depend very much upon the course events may take, this paper would be incomplete without some reference to them. The main facts of the case are pretty generally known. French intrigue, and suspected French designs on Madagascar, have been all along the chief hindrance to the opening up of the island to foreigners. Feeling their insecurity in this respect, the Malagasy—while of late years welcoming Christian teachers, pushing forward education, and making rapid strides in civilisation—have steadily refused to sell land to foreigners, to make roads or railways, or to do anything which would render their country more easily accessible to an enemy from without. A constant fear of French aggression has hung over the Government, and retarded their progress, breaking out in more acute forms from time to time. The events of the past few months have shown how far from groundless these fears were. If the French insist upon their unfounded claims to the north-west coast of Madagascar, which, unfortunately, seems probable, and succeed in inciting the Sakalava on that coast to rebellion against Hova authority, the result of their action must sooner or later be war. Since Malagasy power will not be attacked in a vital part, the war will probably take a guerilla character, and be long continued. The natives, in parts of the island far removed from Antananarivo, will be unable to distinguish between their enemies, the French, and their friends of other nationalities, and foreigners generally

will probably suffer at their hands. The rapid progress of past years will be interrupted, trade with other nations will be stopped, the worst suspicions of the Malagasy will be confirmed, and their confidence in all foreigners rudely shaken. If the French Government take the matter seriously in hand, and equip a strong force to pierce through the forest region, and strike at the capital, doubtless, being the stronger power, they will ultimately succeed in reducing the island to submission, although this will not be an easy task, and cannot prove in any way a profitable undertaking. It is sincerely to be hoped that neither of these two courses will be adopted. Surely the present Malagasy Government deserves a better fate than this at the hands of civilised nations. There is yet ground for hope that when the present soreness wears away, the French Government will approach the matter in a fair and just spirit, give up their unjust claims, and state clearly what their real grievances with the Malagasy are, that they may be honestly and amicably settled. If this were done, then the prospects of the Malagasy people, of late so overclouded, would be clear once again, clearer than ever before, and the path of peaceful progress upon which they have already entered, would still lie open before them.

DISCUSSION.

Vice-Admiral Gore Jones (who stated that last year he was sent on a special mission to the queen of Madagascar), in the course of a description of his visit to that island, said that he thought Mr. Peill had generalised the subject so much as to give rather too low an opinion of Malagasy. With regard to the ordinary native people, of course they did nothing without they were ordered; and the English did pretty much the same thing. As to the upper stratum of society, however, he might mention that the two envoys who met him on his arrival spoke English perfectly, were highly educated men, and most courteous as gentlemen, and generally the upper class were well informed and most gentlemanlike in their behaviour. After describing at length his journey to the capital, Admiral Jones stated that on his arrival at that place he was received by a well-established regiment or two, very well armed with Remington rifles, and perfectly drilled. As he went along, he noticed that the houses gradually improved, and when he got into the Hova country he found, good rough brick houses, and a great increase of comfort and civilisation. As he looked towards the capital, he was very much struck with its likeness to Rome. The speaker then proceeded to describe the special audience which he had with the queen, stating that the Court people were splendidly dressed, and that altogether the sight was equal to anything one might see at St. James's. The queen was a woman of great dignity of manner, and he had heard that she was strictly virtuous and just, and a good woman in every respect, and the prime minister was, without exception, the most remarkable man he had ever met with. He showed the greatest astuteness in the management of the affairs of the island. He described to him the whole scene of the queen having, of her own accord, embraced Christianity from having read the Bible; and stated that he saw the time had come when Christianity was the flood that was to carry them along, and in the public place he brought out the queen. They embraced Christianity before the people, and burned their idols; and as the greater part of the nobles and people followed royalty, as they once did in England, the people also became Christians, and the difficulties of the missionaries were at once removed, their duties being thus changed from those of missionaries to those of instructors. The prime minister abolished the custom of trial by poisoning, a practice which had the effect of decimating the people, and also abolished the importation of slaves from the Mozambique. He (Admiral Jones), therefore, considered, judging from the acts which had been performed in Madagascar within a very short time, that the queen and prime minister were two of the greatest people who had ever lived. The army was between 20,000 and 30,000 strong, and admirably drilled, and in all these reforms the prime minister had one object in view, which was to put the Madagascar nation to the front, to make the queen *de facto* as well as *de jure* monarch of the whole of Madagascar; and, if he had been let alone, he would have accomplished that. The impression left on his (the speaker's) mind was that the Malagasy upper classes were, to all intents and purposes, a governing class, and that if they were left to themselves, they would gradually bring the whole island to embrace Christianity; they would bring about the total abolition of slavery (because the domestic slave was really a slave more in name than in fact), and the result would be one of the most extraordinary islands that had ever been seen in the world, where a coloured race would show themselves possessed of all the capabilities necessary for the development and governing of their country. He regretted that they had, by recent events (with which those present were, no doubt, familiar), been interrupted in their onward progress; and he hoped the passing state of affairs in France would improve matters, and that in England they would do all they could to assist Madagascar as an independent nation.

Mr. Frederick William Verney said that he had been commissioned by his father, Sir Harry Verney, to express his regret that he had been unavoidably prevented from being present at the

meeting, and availing himself of the opportunity to express the strong interest he felt in the fortunes of Madagascar. He wished also to remark that it had struck him, in listening to the paper, how very like Madagascar, in its social and political state, was to our own country in days gone by. There they seemed to have their barons, their nobles, freemen, and serfs, and they had also their social obligations, such as military service, and civil service, which existed in days gone by in this country. Then their tenure of land was particularly interesting, because, as it seemed to him, the old obligations of land tenure which once existed in England were still more strikingly reproduced in the island of Madagascar, since the people there (if he rightly understood the reader of the paper) were not able to get rid of the obligations which were incidental to the tenure of land, even if the land itself passed from them. Referring to the remarks of Mr. Peill as to the condition of the women and the fighting qualities of the men, Mr. Verney said it recalled to his mind most vividly a description which he had once heard that greatest of all missionaries, Dr. Moffat, give of the condition of the interior of Africa, such as he found it when he went there, about sixty or more years ago. It seemed to him (Mr. Verney) that there had been a sympathetic advance both on the mainland and in Madagascar. He remembered Dr. Moffat's description of the entire absence of all the tools of civilisation, the entire absence of machinery; even such a thing as a spade was unknown when he first went into the interior of Africa, and now there were large numbers of machines of all kinds imported; there was an immense trade with Birmingham, Manchester, and Leeds, and others of our great provincia towns. Surely, then, it was not too much to hope that in this interesting island they might see a still further advance. He trusted that Englishmen and people of other civilised nations might be known for something better and something higher than the mere importation of rum and spirits among that primitive race. There was nothing more disgraceful to us as a nation, than to feel that, wherever our soldiers, and sailors, and our civilising agencies went, there were to be found disgraceful scenes, almost entirely owing to a vice which so-called civilised countries were importing into what they termed uncivilised regions. There was one thing which Christianity had done, however, wherever it had spread, and that was, it had tended to raise the position of women and give freedom to all classes of society. Christianity gave the best kind of freedom among all classes; it taught them that every man was a member of the great family of humanity, and should be treated with the dignity of manhood; and it also raised and elevated the condition of women, by putting them in their proper relationship to man, and by cultivating those qualities of purity and virtue which apparently the present queen of Madagascar was so anxious to encourage.

Mr. Martin Wood expressed regret that the report of Admiral Jones's visit to Madagascar had been kept back so long, and considered that if it had been published before, the people of this country would have been better informed about the position of Madagascar than they were. It was not the purpose of the meeting to enter into any political discussion about the matter, but those present could not be indifferent to what they had heard with regard to the struggle that was going on between the all-powerful French nation and the people of Madagascar, who, whatever their strength and soldierly qualities might be, would be unable to stand against any concentrated attack by an European nation, which event, he trusted, might be warded off. Alluding to the French claims on Madagascar, the speaker referred to a statement in the "Army and Navy Magazine" for December, which he said contained such a record of aggression, disaster, and deceit (varied and relieved to some extent by occasional chivalrous and generous conduct), that it was enough to make one shudder. The French had, for a period of 240 years, pursued a policy of self-aggrandisement; but he was glad to believe that there were many public men in France who were opposed to this filibustering policy, which had been manifested lately in that country.

Mr. Liggins said he should be glad to have some information as to the nature of the soil of Madagascar, and as to the prospect of cultivating the land. They had heard a great deal about rice being cultivated, and as rice generally grew in a swamp, it would be interesting to learn that the whole of the ground was not of this nature, but that agricultural industries might be undertaken.

The Rev. Mr. Woodward said, having been for many years a missionary in Madagascar, he could endorse pretty nearly everything that had been stated that evening. He thought it was not quite clear to all that the destiny of the Hovas was not necessarily that of all the tribes. There were tribes in the south of Madagascar perfectly independent of Hova rule; even the tribes in the extreme north of the island did not generally recognise the Hova authority, and on the west coast there were thousands who were perfectly independent of this rule. This fact ought not to be lost sight of in coming to a conclusion upon the subject. On the west coast many of the Hova chiefs were in receipt of an annuity from the French Government, and had, in fact, handed over a portion of the country to the French for a monetary consideration; and the recollection of this fact might prevent many from entering into a feeling of hostility to the French claims. It was an historical fact that it was only by the help of European arms that the Hova chief was able to throw off his allegiance to the Sakalava chief. He considered that the introduction of rum and other spirits into Madagascar by Europeans was one of the greatest possible hindrances to the progress of missionary enterprise, and he

should rejoice if one result of that meeting was to discourage the evil traffic which had existed for so long.

Mr. POOLE, who said he had spent fifteen years in Madagascar, and had been naturalised there, referred to the endeavours which had been made to instruct the Hovas in different arts. They were now able to manufacture tiles, though, owing to the want of coal, they were not able to glaze them. Coal was the great thing needed, and though many substitutes had been tried, none had been found successful. Brick building was now being largely carried on, but the manufacture of china and porcelain had not succeeded, owing to the difficulty of obtaining proper fuel. Gypsum was found in large quantities, but, owing to the same difficulty, nothing had as yet been done with it. Of course the work of the Malagasy was not of so solid description as that turned out by English labourers, but still it would bear inspection. Many of the people could work remarkably well from drawings and plans, and they were very good at manufacturing jewellery; in fact, they had the ability to do almost anything. His own opinion was that the Government of Madagascar had a right to rule their own subjects as they liked, without the interference of foreign powers.

Mr. PRICE said that, from his experience of the island, it was difficult to estimate rightly the influence of the Hovas over the whole of Madagascar. The Government was, no doubt, unsettled in distant parts of the island, but still in no case did the natives defy the representatives of the queen whenever they appeared.

Vice-Admiral GORE JONES said, as there might perhaps be a question whether the Hovas or the Sakalavas were the rulers of the island, he would just mention a few historical facts. In the years 1810 and 1811, the damage done by French cruisers to commerce was so great, that the British Government determined to take possession of several islands from which these cruisers proceeded. At the treaty of Vienna, the island of Bourbon was ceded to the French, and the English retained Mauritius. The question as to the status of Madagascar being referred to England, the British Government decided that Madagascar was an independent country, and that it was to be given over to the king of the Hovas. That was done with the greatest ceremony in the year 1817. On that occasion, the Sakalavas came forward and did homage, and from that day to the present the Malagasy had been ruled by the single monarch of the Hovas. Treaties had been since made, not only by the English, but by the French with the Hovas, and the French had claimed recompense for outrages committed on their vessels from the king of the Hovas; and the warrants under which the English acted for the suppression of the slave trade were given by the queen of the Hovas, so that there could be no question as to which party was in power.

The CHAIRMAN having read a letter from their Excellencies the Malagasy Ambassadors, expressing regret at not being able to attend the meeting owing to an important business engagement, said the discussion related to an island having a population of about five millions of people. It was not within the province of the author of the paper to explain the physical characteristics of Madagascar; the special duty undertaken by him being merely to expatiate upon the social characteristics of the island, and that duty he had most admirably performed. The natives of Madagascar were not far behind the English socially, for if they had not a Divorce Court they had divorce laws. Their army seemed to be based on a territorial system, and to be armed with the best known rifles. They had abolished slavery, and were now on the high road to the development of Christianity, if they were only let alone. He thought there was a tendency in the actions of those who wished to place them under control to further the interests of slavery or forced labour, rather than freedom from slavery. If it was the desire of the governing body in Madagascar to extend civilisation by putting down slavery, he thought they were entitled to English sympathy to that extent. They had a right to sympathise with the people of Madagascar on the broad and general principle that they wished to do to others as they would have others do to them. One very singular instance of advancement was that in connection with the tenure of land, for, as had been pointed out, the twenty-five years term should now be extended to an unlimited extent. With regard to Madagascar and the Malagasy, he might say, as he would of the Kaffirs or any other race, "Why don't we leave the people alone." The Malagasy desired to be left alone to manage their affairs as they thought best. In France, at the present moment, a difficulty existed as to the government, the majority claiming the right to expel the minority; but they did not wish for foreign assistance to settle that difficulty, nor did the Hovas wish for interference when they were exercising their laws. If the Hovas did not wish to make roads from the seacoast from fear of enemies from that quarter, that was their affair and no one else's. The English people had no desire to possess Madagascar, though it was said the French had a desire for the Protectorate of the island; and notwithstanding that that meeting was not the proper place at which to discuss political matters, he might venture to point out that the route to the East was in peril at any moment by its being left open to attacks along that route, or by the Suez Canal. At the present moment the British flag was never seen on vessels carrying the mails to the Mauritius; the mails were all carried by the French, and the Council of Mauritius, which was composed principally of Frenchmen, had rejected an English offer for the establishment of a service of mails. The route *viâ* the Cape of Good Hope was the alternative route, and the real route to the English possessions; and therefore it was important for Englishmen to see that they did not leave themselves open to

possible attack. Parliament would have to consider how the people of Madagascar were to be made subservient to a policy which might endanger English interests, and hinder the advancement and civilisation of the country.

The Rev. J. PEILL, in reply, pointed out that in his paper he had merely dealt with the social conditions of Madagascar; but he was very glad that Admiral Gore Jones and others had taken up other sides of the question. In answer to Mr. Liggins, he might say that already there were coffee and sugar plantations in existence, and as soon as the law as to the tenure of land by foreigners was altered, as it was now being altered in the treaty with America, he had no doubt the number of planters would increase, and that sugar and coffee would be planted on a very extensive scale. The forests were very extensive, being about 2,000 miles in extent, so that there was an unlimited supply of wood, and when roads were made, no doubt there would be a large export of timber. At the present moment indigo and india-rubber were being exported.

Upon the motion of the Chairman, a hearty vote of thanks was accorded to the Rev. J. Peill for his paper.

ELEVENTH ORDINARY MEETING.

Wednesday, February 14, 1883; Captain DOUGLAS GALTON, C.B., F R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Chamberlin, Frederick, 88, Finborough-road, S.W.
Farnan, Walter, 160, Clapham-road, S.W.
Harris, Josiah Rees, 105, Malpas-road, Brockley, S.E.
Jeffreys, Richard Lowther, 3, Pembroke-villas, Haldon-road, Wandsworth, S.W.
Knowles, James, The Hollies, Clapham-common, S.W.
Laudale, Alexander, 12, Westbourne-terrace, W.
Leadbitter, Thomas Francis, Auckland-house, Brondesbury, N.W., and 144, Leadenhall-street, E.C.
Macdonald, A. R., Arthur's Club, St. James's-street, S.W.
M'Creath, James, 95, Bath-street, Glasgow.
Nordenfelt, Thorsten, 53, Parliament-street, S.W.
Ormiston, James, Castlehill Ironworks, Carluke, N.B.
Petty, Adolphus Gray, The Cedars, Stamford-hill, N.
Tarbat, Viscount, 3, Wilton-place, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Albright, G. S., Phosphorus and Chemical Works, Oldbury, near Birmingham.
Bonham, Sir George Francis, Bart., Knowle-park, Cranleigh, Guildford.
Browne, Lennox, 36, Weymouth-street, W.
Edwards, E. Price, Trinity-house, E.C.
Love, William, 21, St. Helen's-place, E.C.
Matthews, James, 23, New-street-square, E.C.
Musgrove, Hubert Musgrove, Barrow-in-Furness.
Rundall, Lieut.-General F. H., R.E., C.S.I., Limehurst, Spring-grove, Isleworth.

The paper read was—

THE SOCIETY OF ARTS PATENT BILL, AND SOME POINTS IN AMERICAN PATENT LAW AND PRACTICE BEARING THEREON.

BY SIR FREDERICK BRAMWELL, F.R.S.

Those who read the *Journal of the Society of Arts* are aware it has been arranged with Sir John Lubbock that the Patent Bill prepared by this Society, last year, shall be re-introduced in the Session of Parliament now about to commence, and shall be re-introduced without any alteration whatever.

This determination was arrived at by the Council on the recommendation of the Patent-law Committee, after that committee had met and considered the subject, having had the advantage of the presence of Sir John Lubbock at their meeting.

In view of the fact that the Council determined to ask Sir John Lubbock to re-introduce the Bill in the coming Session, I thought I could not do better than select last autumn for a long contemplated repetition of a visit to the United States, as I should thus have an opportunity of conferring with those interested in patent matters there, and of ascertaining how far the present Patent-law and patent practice of the United States directly supported the changes, or some of them, put forward in the Society's Bill; how far they were neutral as regards those changes, and how far, if at all, they were in opposition thereto; and I also desired to ascertain the opinions of persons in the United States conversant with patent matters, as to such propositions in the Society's Bill as are not comprised within the present law or practice in America.

With the foregoing object, I put myself in communication with many persons competent to advise on patent matters; among whom were patentees, manufacturers, lawyers engaged in patent practice, and, I am glad to say, the Commissioner of Patents at Washington, Mr. Marble. I have to thank all my friends for their attention, and specially I desire to express my thanks to Mr. Marble, who, in addition to

furnishing me with numerous documents, was good enough to discuss the general question, to express his views thereon, and to give me his permission to publicly state those views as his.

Before considering the details of the way in which American law and practice bear upon our Bill, I find myself compelled to make some general remarks upon the broad question of inventors and patents in the United States, as contrasted with inventors and patents in the United Kingdom. The first thing that strikes an Englishman, accustomed to consider these subjects in his own country, and to hear the views not infrequently expressed there respecting them, is the totally different feeling that prevails among the public generally in the United States, and (no doubt, as a consequence of this different feeling) the difference in the spirit with which patent matters are dealt with by the United States Government.

This feeling is well shown by the following passage in the report of the United States Patent Commission, issued in 1870, when the question having been raised as to whether certain reports were worth their cost, the Commissioner expressed his opinion thereon, and on the value of patents generally, in these words:—

"In view of the great benefits which the patent system has already conferred upon the nation, single inventions—like the sewing-machine, the harvester, the telegraph, or vulcanised rubber—having more enriched the country than the whole system has cost from its inauguration to the present time, I believe that the expense of retaining the mechanical report, in addition to the new publication, would be fully justified."

It cannot be doubted, that in England, some ten years ago, those who held themselves out as the leaders of thought and of opinion were, as a rule, opposed to patents. The political economist and the freetrader detested them as conferring monopolies; the lawyer detested them because he might have either as counsel to argue upon them, or as judge to preside at a jury trial, or without a jury even to decide a patent action; and, whether as counsel or judge, he had no kindly feeling towards that which gave him extra trouble, by involving him in the consideration of matters which, except in rare instances, were foreign to his ordinary pursuits and train of thought. In fact, patent cases were a deal more troublesome than those for "goods sold and delivered," and they did not afford the amusement of a prolonged action relating to a racy libel, or other *cause celèbre*. The successful manufacturer disliked patents, because the development of the inventions covered by them might interfere with his established business, carried on in a way that he understood; might cause his existing plant to be superseded, and be reduced to the value of old metal; thus inflicting on him the double annoyance of having to go to school in his mature age to re-learn his business, and to find fresh capital to purchase new plant. The man engaged in pure science was no friend of patents, he was occupied with the discovery of principles and of laws. Principles, as we know, are not "subject matter." Patents deal not with principles, but with their applications, and thus render useful to the community the otherwise barren discoveries of pure science.

I will not weary you with other instances of dislike to patents, and of the reasons more or less avowed for the dislike, except the one instance of the dislike expresed by persons who put themselves forward as the "friends of inventors." These persons looked upon inventors as being a class so wanting in ordinary intelligence, that they should be protected, not in their inventions but from their inventions. Even those who agreed that, on the whole, patents should be granted, did so with an uneasy feeling that they were doing wrong, or, at all events, they were not doing quite right, and looking upon the patentee as the adversary instead of the benefactor and ally of the public, thought it not unbecoming the Patent-law should be so framed as to trip up the patentee for the advantage, as was ignorantly supposed, of the public.

I quite agree that, whether expressed by the "S.G.D.G." attached to a French patent, or whether left to be understood without any such formal notice as "without guarantee of the Government," intended by those four letters, it is not reasonable to expect that any Government should be called upon to guarantee the validity in all particulars of the patents it grants; but there are certain matters entirely ascertainable by the grantor, and among these is the question whether that invention which the applicant desires to protect by a patent is "subject matter," and competent or not competent to be patented. This, at least the grantor, the Crown, could and ought to determine; but, as we know, the Crown, although it purports to make inquiry on this point, considers that inquiry of

so little value, that it permits any private individual, who may happen to be a defendant in a patent action, to challenge the conclusion arrived at by the Crown as the result of that inquiry, and to plead before the Royal Courts of Justice that the Crown had made a mistake, and had granted a patent for that which, according to law, was not patentable, and the defendant may succeed in this plea. I do not remember ever having heard that, under such circumstances, the Patent-office returned to the deluded patentee the fees he had paid. This seems to me very much like obtaining money under false pretences; but then, according to the view which, as I have said, prevailed on the subject of patents until within the last ten years, it was felt that, although the means savoured of that which was evil, the laudable end of throwing open before its time an invention to the public did away with the evil, and, in fact, sanctified the means.

About eight or nine years ago, however, I am glad to say, the current of opinion ceased to flow so strongly against patents. Some of the political economist opponents, seeing the great progress of the manufacturing industries of America, and knowing of the prevalence of patents there, had it forced upon them that the existence of patents did not of necessity hamper trade. Many of the younger race of lawyers had included scientific subjects in their education, and were not averse from questions involving either mechanics, chemistry, or physics. Manufacturers, even with old established businesses, had recognised that if they would not come forward, others, either at home or abroad, would do so; and had thought that it was better to keep a leading position, at the cost of some trouble and some money, than to allow themselves to be passed by others. The literary man also found the difficulty growing upon him, the more he studied it, how to discriminate between copyright and patent-right, and to see why the description of a new invention should be protected by copyright if the invention itself was to be without any protection whatever. In fact—to use a figure borrowed from the behaviour of tidal rivers—we may, I think, at the present day, say that not only is the adverse downward current flowing with less strength, but there are, as there are at the turn of the tide in a river, currents making their way in the opposite direction. We know that in a tidal river these currents, though small, and confined to the river side, are the true indications of the forces then prevailing and about to prevail, while the more conspicuous downward current in the centre is but due to the energy remaining in the moving mass, though the force which originally set that mass in motion has ceased to operate.

Notwithstanding, however, this improvement in public opinion as regards inventors and patents, that opinion is not yet in a thoroughly healthy state. I commonly hear the jeering remarks that are made about most men who exercise themselves in invention, not about all men who do so, for it has been well said "there is nothing succeeds like success," and when a man has become known to the public as a successful inventor, he may further invent without reproach, although the very subsequent inventions of such an one would, had they emanated from a beginner, have given rise to the common sneer, "Oh, so and so has become an inventor;" the fact is, if the man is your friend, and you are advocating, say, his fitness for election into some club or society, you have to confess that he was weak enough to invent, but that it was done in a thoughtless moment, and to express your belief that hereafter he will refrain from any such reprehensible conduct, and, if admitted into the club or society, will henceforth behave himself with the utmost decorum.

This grudging acknowledgment of patents and patentees is shared in by the Government. I don't mean the Government of the present day, or that of any other political party, but I mean those in power for the time being. Instead of looking upon inventors and inventions as being the source from which improvement, and thereupon, prosperity, comfort, health, and the maintenance of the revenue of the country depend, they regard them with jealousy, and doubt whether the Patent-laws, that give property in invention, ought not to be abolished; but feel sure that while they are continued, their only, or at all events, their greatest utility is that of adding by a voluntary taxation to the income of the country. Thus it is that the Government, while taking over £200,000 a year from patentees, grudge the expenditure necessary for proper buildings, efficient staff, efficient control, creditable publications of the patents and their drawings, and room to store them. And to save money, and to be able to pay over to the general revenue of the United Kingdom a net sum of over £160,000 per annum, they purport to manage the patent business of that kingdom by a body of lawyers, all of whom, with one

exception, vanish with the Government of the day, to be succeeded by a fresh set, who, by the time they have learnt something of their business—assuming they had even leisure from their other duties to learn it all—have, in their turn, to disappear. This is treating invention and improvement as though they were bound up with Conservative and Liberal, or Tory and Radical; while the fact is, we are thankful to know, that invention has no politics.

How different from all this is the state of things in America, and is so whether one looks at public opinion and feeling or at the conduct of the Government, the reflex of that opinion and feeling. If you talk with men of position and influence in America, you find they speak with pride of the inventive fecundity of their countrymen; if they wish to interest you in a man whom you are about to meet, they will commonly do so by relating his inventions. In America, it is well understood that to their inventors they owe their success in manufacture, and the inventor is, therefore, with them, looked upon as a benefactor, and as one to be encouraged and not to be sneered at, as he too often is here. All unconsciously many an Englishman recognises the development of American industries due to inventions, for it is a common thing to hear said, when something peculiarly novel and ingenious is being discussed, "I suppose this comes from America."

Next, as regards the action of the Government. How do they treat inventors? And, first, what accommodation do they afford for the patent business? Upon this point, although it is a thrice-told tale in these rooms, I must refer to that which strikes the eye of anyone visiting Washington. Among the many fine buildings of that City, the one that takes the second, or the third place, is the Patent-office. The Capitol comes undoubtedly first, whether the Treasury or the Patent-office comes next, I am not quite clear, but I am clear that the Patent-office is a building measuring about 450 feet by 300 feet of handsome elevation, and of excellent material (white marble), and surrounded by fine streets on all four sides. In this building, there are a staff of 491 persons engaged on the patent business, which staff is about to be increased, the whole superintended by a Commissioner of Patents. Notwithstanding the small fees paid by patentees, the receipts, in 1881, were 853,000 dols., or £170,600; and I was told that the receipts for the current year would be 1,000,000 dols., or £200,000, while the expenses of 1881 were £116,000. With the object of diffusing information regarding patents throughout the vast territory of the United States, as many as 20,000 copies of the Patent-law, and of the Rules, are sent, per annum, gratuitously to different parts, while, as a proof of the interest taken by the public in the subject, I was informed that the average daily sale of specifications has amounted to 2,000 copies.

You may perhaps say that I have wandered from the true subject of my paper, or in patent language, that my Specification and Claims do not accord with my Title; but if need be, I will ask leave to amend my title, for that which I have been saying I have said with an object, which to me, at all events, appears germane to the present subject, and that is the object of showing that the Americans believe in patents, and are interested in them; that, in the United States, patents have the sympathy of public opinion and of the Government; and that, thus it is not unreasonable we should endeavour, when trying to amend our own laws and practice, to look at what such a people have done, and, so far as appears good, to be guided thereby. At the same time, I am sure, from the freedom with which our American friends criticise in all departments their own laws, they would be the last to assert that they were infallible even on the question of patents; and thus it is open to us to depart, in any new law in England, from their law and practice, should we, on reflection, find it advisable so to do.

I will now proceed to consider in detail some of the points in which the Society of Arts Patent Bill differs from the law of 1852, and, in doing so, will notice to what extent it also differs from or accords with the abortive Bills of the late Government—or, rather, in the interest of time, will consider how far it differs from the last of these Bills only (that brought in by Sir John Holker, in 1879), as this Bill was far better than any of those which preceded it; and will see whether the United States law and practice support the changes we propose, whether they are opposed to those changes, or whether they are merely neutral.

The Society of Arts' Bill is divided into Four Parts. In the first of these Parts, that which primarily demands attention on the present occasion is the provision in Clause 3, that "An invention is deemed new for the purposes of this Act if it has not been published or publicly used in the United Kingdom, the Channel Islands, or the Isle of Man within

the thirty years immediately preceding the date of the application for the patent for it." I cannot appeal to the American Patent-law for a precedent for this alteration; but I am glad to say that, in discussing the question with my American friends, and with Mr. Marble, the Commissioner of Patents, he and they all agreed that the ground on which we based our alteration was a sound one, and that the alteration itself was desirable. The ground, as you know, is this—that it is in the interests of the community, and in that of the progress of manufactures, inventions should be the property of some person or persons having a strong interest in getting them used and in developing them; and that it is not in the interests of the community that inventions should be open to all who choose to use them, for this means in practice that they will not be adopted. In fact, to quote for the thousand-and-oneth time the happy illustration of our Chairman of Council, Dr. Siemens, "If an orphan invention were found lying in the gutter, it would be to the benefit of all that an owner should be assigned to it." If this be true, as I most firmly believe it to be, it is quite clear that, in the case of an undeveloped and forgotten invention, crystallised in some book published a generation back (30 years), and unused in all that time, that it is well for the community the discoverer of this buried invention, or the absolutely independent re-inventor, should have the incentive to endeavour to cause this invention to be used and developed which arises from ownership and a hope of reward.

I will pass over anything further in the "interpretation of terms," as I think the subjects to which they relate may be better dealt with when considering the different clauses.

The next matter that appears to demand comment is Clause 5, "Subject Matter of Patents." Hitherto, we are all aware, the only guide as to what shall be patentable in the United Kingdom has been the expression in the Act of the 21st of James I., c. 3 (the Statute of Monopolies), that it shall be "any manner of new manufactures." It is well known why this phrase was introduced—it was to guard against the bestowal by the Crown of monopolies of existing industries upon favourites. What, however, "any manner of new manufactures" may mean for patent purposes, can only be ascertained by collecting the records of those patent cases where this question has been in serious issue. There was much discussion on this part of the Society's Bill. It was held by our legal friends that it was undesirable to throw overboard well-established precedents, and to attempt to replace that which existed by definitions which, with whatever care they might be drawn, must, it was feared, fail to embrace some instances now properly recognised by the law, according to the interpretation of the Courts, as patentable matter; on the other hand, it was obviously desirable to get rid, as far as practicable, of any uncertainty on this head. Finally, it was determined to employ "any manner of new manufactures," and to supplement it by further definitions. The clause now stands as follows:—

(*a*) Any manner of manufacture;
(*b*) Any product not being a natural product;
(*c*) Any machine, or any means of producing any manufacture product or result;
(*d*) Any process or method of producing any manufacture product or result;
(*e*) Any part of a machine means process or method of producing any manufacture product or result.

On this point we are justified by the United States law, which defines what shall be patentable, viz., "any new and useful art, machine, manufacture, or composition of matter, or any new or useful improvement thereof."

This "subject matter" question was not touched in the Government Bill of 1879, as in that the old description, "any manner of new manufactures," was retained without alteration or addition.

The next points to which to call attention are those dealt with by Clause 7, the marginal note to which is "Case of Inventions Patented Abroad." By the 25th Section of the Act of 1852, an English patent could not be obtained for a foreign invention patented abroad in the unlikely case of the foreign patent having expired before the patent was sought for in the United Kingdom, and, assuming an English patent to have been granted during the continuance of the foreign patent, then the English patent was to expire with the foreign one, or, in those cases where there was more than one foreign patent the English patent was to expire with that one of the foreign patents that first expired. Moreover, under the existing law a patent can be obtained by a person in England for an invention seen abroad, or communicated from abroad, to the detriment of the real inventor. By Clause 24 of the Bill of 1879, it was proposed, among other alterations, that where there was not any foreign or

colonial patent in force in respect of the invention, a patent should not be granted to anyone but the inventor, or his legal personal representative, and that where there was a foreign or colonial grant in force, that then the English patent should be accorded to the foreign or colonial grantee (or to his legal personal representative) only; but the grantee was bound to make such application within six months of the date of the earliest of his foreign or colonial patents (if more than one), and the English patent was to cease, as in the 1852 Act, on the cesser of the foreign or colonial grant first to cease if more than one, and, also as in the 1852 Act, a patent was not to be granted after the cesser of any foreign or colonial patent. There was a provision, however, in this Section 24 of the 1879 Bill, that the validity of the patent, if granted, should not be affected by the publication in the United Kingdom, of any documents officially connected with the foreign or colonial patent. Clause 7 of the Society's Bill agrees with Clause 24 of the 1879 Bill, in the not granting of a patent for a foreign invention to anyone but the inventor, or his legal personal representative; but it proposes to give him eighteen months instead of six months after the date of his foreign or colonial patent, as the period within which he may make application in England; and, similarly to the 1879 Bill, it proposes that during the time which may elapse between the date of the foreign patent and that of the application for an English patent, he shall not be prejudiced by the publication, in England, of documents connected with the foreign or colonial grant. Unlike, however, the Act of 1852 and the Bill of 1879, the Society's Bill provides that the English patent shall not cease with the cesser of the first to cease of the foreign patents, or with the cesser of any foreign patent at all. The upholders of the provision for the cesser of the English patent based their support of that measure upon the ground that the foreign inventor, having obtained a patent, say in his own country, had thereby communicated to the people of that country the nature of the invention, and that if his patent there were to cease in any way, his countrymen would know all about it; they would not have to pay a royalty to the patentee, and would thus be in an unfairly advantageous position in competing with the Englishman having to pay such a royalty. When these persons were asked how much worse the Englishman was off under these circumstances than if the foreigner had never patented his invention at all in his own country, they were driven to say that if he had not patented it, then it was to be assumed that his countrymen would have remained ignorant of the invention. It is very unlikely that this could have been true at any time, but most certainly it can never have been true since the establishment of technical journals, freely interchanged between all the countries of the world. Great hardships have occurred from this provision, and the Society of Arts Bill, by Sub-section 3 of Clause 7 does, as I think, wisely in providing "The patent, if granted, shall not be affected as to duration or otherwise, by the expiration or determination in any other manner of any foreign or colonial grant."

I cannot say that the existing American law justifies the proposition of the Society of Arts, but I certainly can say that American opinion justifies it. This appears from the United States Patent-office Report for 1873, in which the Commissioner says:—"I would suggest that this section be so amended as to make the duration of an American patent entirely independent of the duration of a foreign patent to the same person."* Further, in the 1881 Report of the United States Patent-office, there occurs this sentence:—"I therefore recommend that that part of Section 4887 of the Revised Statutes, which limits the term of the American patent by that of the foreign patent, be repealed."† These opinions still prevail. I asked the Commissioner of Patents what alteration in their law was wished for, in the United States, and I was told that the one section of their law to which objection was raised by the Americans was that which caused their own patent, of otherwise seventeen years' duration to cease, with an English patent of only fourteen years. I was further told that, within the last two or three years, Judge Blashfield had ruled that the fact of an English patent having been allowed to lapse, by non-payment of the stamp duty, did not involve the cesser of the American patent, as he held that that continued in force until the completion of the full term originally granted by the English patent.

By Clause 8 of the Society's Bill they propose that the management of the Patent-office shall be under three Commissioners, one of whom shall be experienced in engineering, one

* This report is reprinted in the British *Commissioners of Patents' Journal*, February 20, 1874, p. 518.

† See *Commissioners of Patents' Journal*, March 21, 1882, pp. 733, 734.

in chemistry, and one in law. In the Act of 1852, the legal, and nothing but the legal element, was definitely provided. The Lord Chancellor, the Master of the Rolls, the Attorney-General, and the Solicitor-General for England; the Lord Advocate, and the Solicitor-General for Scotland; the Attorney-General and the Solicitor-General for Ireland, were all to be Commissioners. Eight great lawyers, seven of whom depart with the Government. But, it is to be presumed, the framers of this Act did not feel quite satisfied that this was a satisfactory body for the conduct of a patent business, and therefore the first section goes on to say that the before-mentioned officials "together with such other person or persons as may be from time to time appointed by her Majesty, as hereinafter mentioned, shall be Commissioners of Patents;" and then follows a provision that it shall be lawful for her Majesty to appoint by warrant such other person or persons as she may deem fit to be Commissioners, and that all the powers of the Commissioners may be exercised by any three or more of them, the Lord Chancellor or the Master of the Rolls being one. As we all know, in spite of repeated expressions of desire that this other or these other persons should be appointed, nothing up to this time has ever been done. The Bill of 1879, while retaining the eight officials, suggested (see Clause 5) that her Majesty should appoint five other persons, two on the recommendation of the Lord Chancellor, and three on that of the Board of Trade; but these five persons were to be unpaid. Does not the provision in the 1879 Bill, for the appointment of these five Commissioners, involve either that the law officers have been compelled to leave so much of the Patent-office work undone as to provide occupation for five other Commissioners, or that the five new Commissioners, who were to be unpaid, were really to do the work to the relief of the law officers, who were still to be paid? The Society of Arts Bill does not propose to touch the salaries of the law officers. These officers of the Crown must be paid, and if it please Parliament to let that payment come directly or indirectly out of the Patent fees (it will be remembered that the salaries of the law officers are now derived from the Consolidated Fund, to which fund the receipts from the Patent-office are paid over), so be it; but we do respectfully suggest that these law officers have other and important work to do, including their Parliamentary duties; and that the manufacturing interests of this country would be benefited by their attending to those other duties, leaving patents to be looked after by three gentlemen unburdened with any other pursuits, and having special aptitudes for the work of the Patent-office. In this provision of the appointment of persons specially devoted to the business, we are fortified by the practice of the United States, who appoint a Commissioner, an Assistant Commissioner, and three Examiners-in-Chief for that purpose.

Clause 9 of the Society of Arts Bill empowers the Commissioners to appoint examiners. No such provision was made in the 1879 Bill. It need hardly be said, however, that the United States affords ample precedent for such appointment. The duties of these examiners will be considered further on.

Clause 10 of the Society of Arts Bill relates to the application for a patent. With respect to Sub-sections 1 and 2, the applying for a patent, and lodging a provisional specification, and the publication of the fact by the Commissioners, these practically agree with Clause 6 of the 1879 Bill, and do not differ materially from the corresponding provisions (see Sections 6, 9, 11, and 12) of the Act of 1852; but Sub-sections 3 and 4 of Clause 10 of the Society of Arts Bill, which provide for the destruction or for the keeping secret of the provisional specification, do differ from both the Bill of 1879 and from the Act of 1852, and in this proposition the Society of Arts is supported by the practice of the United States Patent-office. Holding, as the framers of the Society of Arts Bill do, that it is desirable inventions should have an owner, they believe that much harm is done by the present system of publishing the provisional specification in those cases where the patents are not granted, as in this way there is too commonly made known so much of an invention abandoned by its inventor as may, when interpreted by the light of subsequent knowledge, be held sufficient to prevent a subsequent inventor from having a valid patent, while leaving the invention crude and imperfect, altogether useless, and without an owner to see to its development. In the United States, in the event of a patent not being granted, the document corresponding to the provisional specification is kept secret. With respect to the proposition for the secrecy of the provisional specification in those cases where the patent is granted, I shall have some observations to make upon that presently.

Clauses 11, 12, and 13, of the Society of

Arts Bill, may well be considered together. By 11, nine months' provisional protection are given; but, by 13, before the end of six months, the patentee, if he intends to proceed to the seal, must lodge his complete specification. Clause 43, however, gives the Commissioners power to extend the period of provisional protection to twelve months. Clause 12, in so far as it provides for an examination, while not agreeing with the Bill of 1879, is fully supported by the American practice. It will be seen by *a* and *b* of Subsection 1 of Clause 12, that the examiner is to ascertain whether the invention is subject matter for a patent; whether its nature is sufficiently indicated by its title; and whether the provisional specification is in accord therewith. As I have said in my opening remarks this evening, it appears to us to be indefensible that the Crown should take fees from a patentee, and grant a patent which they, but not the patentee, know to be bad, and then tell him when he gets into a Court of Law, but not till then, "the patent you paid for is worth nothing, for the invention relates to that which is not 'subject matter.'" The obvious remark of the patentee is, "Why did you not find that out before you took my money?" Similarly money is taken for a patent which is afterwards declared to be bad, because it does not agree with the title. We hope, by a system of examination at this stage, to ensure a valid patent, so far as these two now present heads of objection go. But to guard against the chance of an intending patentee being injured by a groundless adverse report, we provide an appeal, and we ensure that even if the appeal is against the patentee, he may still have his patent, on condition, however, that the patent and its specification, and every copy thereof, shall bear on it the statement of the report of the examiner.

The next matter calling for comment is (see Clause 15) that the complete specification shall be examined, with the objects of ascertaining whether it accords with the title, whether it is covered by the provisional, and whether the whole nature and object of the invention are stated with sufficient clearness, by which is not meant the clearness necessary to inform a workman how to carry out the invention, but the clearness necessary to enable a reader to ascertain what really is the scope of the patent. Again, even in the face of an adverse report, power is given to the applicant, if he insists, to have his patent, but subject to the endorsement. So far as examination is concerned, the American practice justifies this clause of the Society of Arts Bill; but, as is well known, in America they go further, and examine into novelty, and they have, at the present time, twenty-five divisions, with five examiners in each division, and I was told that this staff must be increased. The paper is becoming so long, that I will not enter into the grounds on which the committee came to the conclusion that it would be unwise to have an examination into novelty. As far as my own opinions are concerned, these are to be found at p. 111, of vol. xxiii of the *Journal* for the year 1874. The 1879 Bill did not propose any examination whatever; the Committee of the Society of Arts proposes the limited examination above referred to, because they were of opinion, as I have said, that the man who pays his fees should be assured that he is not paying them for a patent which he may afterwards be told should never have been granted, because it is contrary to law, or because it does not accord with the title, or because it is in excess of the provisional specification (all matters that may well be determined before the grant of the patent), and, further, because the public are entitled to have a specification framed with sufficient clearness to enable a reader to understand what are the boundaries of the patent, within which boundaries the public are not to trespass.

It will be seen that, by Clause 17, the Bill proposes to confine the opposition to the granting of a patent to such person as may be in a position to allege that the applicant has obtained the invention from him, or from some one of whom he is the legal personal representative. The Act of 1852 (by Section 12, and and not Section 8, as erroneously printed in the reference in the Bill of 1879, which error has been repeated, I am sorry to say, in the reference in our Bill) says that "any persons having an interest" may oppose. I should have thought this sufficiently wide language, but the Bill of 1879 used still wider, for that says, by Clause 10, that "any person" may oppose. It is to be presumed that these wide powers of opposition were based upon the old notion that an inventor was the enemy of the public, and that, therefore, anyone ought to be let in to combat him. With respect to the American practice on this point, it supports the proposal of the Society of Arts, as it confines "interference," as they style that, which we call opposition, to those who claim substantially the same invention.

The 18th and 19th Clauses of the Society of Arts Bill relate to the sealing. It will be seen, it is proposed, as in the 1879 Bill, that every patent should be sealed as of the day of its date, but that, contrary to that Bill, the date must invariably be the date of the application, and also, contrary to that Bill, the seal is to be that of the Commissioners, and not the great seal of the United Kingdom. By the practice under the Act of 1852, an applicant is tempted to cut short the period of trial allowed him by the provisional protection, with the object of "racing for the seal." The Bill of 1879 and this Bill both propose to put a stop to the practice.

Under the United States law, there is no temptation to "race for the seal."

Clauses 20 and 22 relate to the duration of the patent, which, in accordance with the American practice, it is proposed should be seventeen years; the Bill of 1879 suggested twenty-one years. Great objection was made to this on the part of many manufacturers, and it was felt by the Society of Arts that there was validity in those objections, and that the seventeen years, based on the American usage, would be a happy solution of the difficulty. The 22nd Clause deals with the periods at which patents would cease unless further payments were made. Having regard to the total life of seventeen years, the fourth and eighth years are suggested as these periods, in lieu of the third and seventh years of the 1852 Act with its fourteen-year period. A time of grace is also provided, as in the 1879 Bill, should a patentee fail to make the payment by the exact date.

As, no doubt, most of you are aware, no such practice as this prevails in America. The patent, when granted, endures in all cases (except in that of patents for designs) for the whole seventeen years. I think, in this particular, our Patent-law is better than the American, as it provides for the cesser of those patents which experience shows to be practically of no value, and in this view I am again supported by recommendations in the United States Patent-office Reports. For in that of 1874, before quoted, will be found the following:—"I am convinced that it would be to the interest of inventors and the public, that holders of patents should, at the expiration of six or seven years from the date of the patents, be required to pay into the Patent-office a sum of, say, twenty dollars, otherwise their patents to become void. This would, probably, sweep out of existence fully twenty-five per cent., or perhaps a larger proportion, of all the patents granted."

Clause 23 of the Society's Bill deals with the amendment of the specification; Clause 17 of the 1879 Bill relates to the same matter, and both go much beyond the powers given by Section 39 of the Act of 1852, which section was itself based upon the earlier Act of 1835. All those who have dealt with patent matters must know that too frequently a patentee has occasion to say, "If I had the power of re-drawing my specification, with the insight I now have into the working of the invention, how much more clear I might make it, while keeping entirely and honestly within that which was really my invention, as stated in the title, and as foreshadowed in the provisional specification." Moreover, he might say, "I am advised that the true legal construction of my claims is such that they do not embrace that which I thought they did, and to which I am in truth entitled; for I have invented it, and thus, from a mere defect of language, I am to be deprived of that which is properly mine." We propose that this state of things should be remedied, and that a patentee should not only be entitled to amend, by way of excision or disclaimer as at present, but also by way of addition, provided that this addition does not go beyond that which the patentee might properly have claimed at the outset. (See Sub-section 3.) The American practice of a re-issue affords ample support for this proposition. It will be seen that, as in the case of examination, this question of amendment is largely, if not quite, dependent upon there being a proper body of Commissioners understanding the subject, and having no other duties to attend to.

The same remarks as to the Commissioners apply to the next provision of the Bill (see Clauses 24 and 25 relating to "prolongation"). By these, the Society suggests that, as at present, there shall be power of prolongation, but decreased the three years, by which the life of the original patent is increased, so that the total existence of the prolonged patent under the Society of Arts Bill should not exceed that under the 1852 Act, or, more strictly speaking (see Section 40 of that Act), under the provisions of the Act of 1844. Neither the American law nor the 1879 Bill provide for prolongation, but, in the opinion of those in this country most competent to judge, there are cases where prolongation is absolutely needed, and such cases might well be left to the discretion of a specially competent

tribunal, such as would be the Commissioners suggested by the Bill. In this instance, the Society of Arts propose that opposition shall be confined to those persons who have real interest in the matter, and the Bill also (see Sub-section 3 of Clause 44) forbids the Commissioners inflicting the costs upon an unsuccessful applicant for prolongation, except in the case of fraud.

Clause 26, and the third schedule to which it refers, relate to the stamp duties to be paid. It will be seen that under these a patent, existing without further payment for four years, can be had for a total expenditure of £7 10s., instead of the £25 of stamps and fees now payable for three years; while, if the patent runs the whole seventeen years, the total stamp duties amount to £77 10s., instead of the £155 of stamps and fees now payable for fourteen years. The Bill of 1879 proposed a payment of £12 10s. for the three years' patent, and £262 10s. for a patent running the whole twenty-one years, the term suggested by that Bill. The Americans' charge for the whole term is thirty-five dollars, or, in round figures, £7.

By Section 27, the patent is to have the like effect against the Crown as against the subject, but with a provision to enable the Crown to use for military purposes the patentee's invention, even in default of agreement with the patentee, upon terms to be settled by the Commissioners. This Clause is very similar to Clause 18 of the 1879 Bill, but there, in default of agreement, the Treasury was to be the arbiter, assisted, however, by the Commissioners, suggested under that Bill. In America, the law, as regards this point, appears to be that the position of the State is the same as that of a private individual.

By Clause 29, in certain extreme cases, to be judged of by the Commissioners, a patentee may be compelled to grant licenses. This provision has been inserted by the framers of the Bill, to meet the objections of those persons who allege it to be possible that a patent may be held for the purposes, not of use, but of obstruction. The 1879 Bill, by its 19th Clause, had a similar provision, but with far fewer protections for the patentee, and with the condition that the Lord Chancellor was to be the judge as to the proper terms for the license. Moreover, this Clause of the 1879 Bill proposed to revoke the patent if not put into operation within a given time. It was pointed out to the Government that this was an illusory and an oppressive provision, and quite unneeded if there were power to order a license to be granted. With respect to this, the American law gives no power either to revoke for non-user or to compel a license.

There are some other Clauses in the First Part of the Bill which might well call for remark, such as the 34th, 35th, and 36th, relating to revocation; the 38th, extending the time after the publication of an invention at any industrial exhibition within which the patent may be obtained for such invention; the 46th Clause, providing for assistance of assessors; and the 48th, providing for the salaries of the Commissioners and Examiners, but time will not admit of this being done, as I wish to make a few remarks upon the Second Part of the Bill, relating to the infringement of patents.

Clause 58, as has been already incidentally mentioned, provides it shall not be competent for a defendant to plead that the patented invention is not proper subject matter, and it also forbids his taking any objection to the patent, in respect of any other matter contained in it, than that alleged to be infringed. The Bill of 1879 contained neither of these provisions. With respect to the American law, I am sorry to say I do not know what the practice is, as regards the plea of the invention not being subject matter; but I do know that (although I believe the law is silent on the subject) the Courts hold that a defendant is not entitled to object to any matter other than that alleged to be infringed. I may mention, incidentally, that the French pursue a similar course.

It will also have been noticed that the clause which keeps the provisional specification secret, in effect does away with the power of the defendant to allege that the patent has been granted for an invention in excess of that of the provisional specification; a point which, by this Bill, is determined by the examiners.

Although the following matters have, I believe, nothing analogous to them in American practice, or in the 1879 Bill, they are so important, especially those matters referred to in Clauses 63, 64, and 65, that I do not like to pass them over.

By Clause 62 of the Society's Bill, a patentee who brings an action upon a patent bearing an adverse endorsement, is bound to find security for costs.

Clauses 63, 64, 65 make provisions which, in the opinion of the framers of this Bill, would go far to remove the existing objections to the trial of patent actions. But, again, it is

necessary that a body of Commisioners of the kind indicated by the Bill should be provided.

Clause 63 imposes upon the Commissioners the obligation to act as assessors to the High Court of Justice, or to a Judge thereof.

Clause 64 empowers the Court or a Judge to refer to the Commissioners a patent action which might be referable, under the Judicature Act, to an official referee; while Clause 65 enables a plaintiff and defendant, if they agree so to do, to demand that the Commissioners shall act as arbitrators, and imposes on the Commissioners the duty of thus acting.

The remaining parts of the Bill are, I believe, purely formal, and I need not, therefore occupy your time by referring to them.

I am aware that the foregoing paper is very dry and very tedious, but I really do not know that it is possible to treat in detail successive clauses of a highly technical Bill, without laying oneself open to this remark, and I can only hope that the great importance of having satisfactory legislation in respect of protection for invention will be held to be a sufficient excuse. That such protection is important there should be no doubt, as without invention, and invention carried to development, the manufactures of this country would most certainly cease to progress, even if they did not cease to exist.

DISCUSSION.

The CHAIRMAN, having expressed his regret at the absence of Mr. Webster, Q.C., who had been announced to preside, but who, at the last moment, was unable to come, being detained at Leeds by important professional business, proposed a vote of thanks to Sir Frederick Bramwell for his paper. Amongst the most important of the questions which it raised, was whether we should in England follow the old practice of regarding the inventor as the enemy of the public, or adopt the American view, that he was a benefactor to the community. The Society of Arts Bill had been drawn on the latter view, and he was very glad to find that it was to be again introduced in the ensuing Session of Parliament.

Mr. W. E. NEWTON said he expected to have heard more about the practice in the American Patent-office, especially with regard to examinations. There was now very little in the Society of Arts Bill to which he objected, but he must refer to one point, and that was the examinations which it was proposed to provide for. He had hoped to hear something about examinations for novelty; and should be quite willing to have all applications examined as to novelty, in order that the supposed inventor might be informed if he were not really the true and first inventor; but the new Bill did not touch that subject. He thought it would be useless to have examinations in the Patent-office if they were not to be applied for the only purpose for which they would be of any use. Was it really worth spending public money to ascertain whether the title agreed with the provisional specification? Any competent patent agent could give the patentee that information. He raised no objection to the examination of the provisional specification to see if it were clear and intelligible; it was not a document of much importance, and he cared very little what was done with it · but with regard to the complete specification, a work of great labour, on which had been concentrated, in many cases, the work of many minds; if this, when approved by the patentee, were to be examined by some official to see whether it was sufficiently clear and intelligible, he thought there ought also to be an examination into all the title-deeds which were registered in Middlesex and other registries to see whether they were intelligible, and whether there were proper maps annexed, with carefully prepared boundaries. If a specification were drawn on the responsibility of the patentee, he had a right to file it, and let it stand for what it was worth; and he thought it would be well if the promoters of the Bill would give over that motherly care for patentees, as he had heard it called, doctoring their specifications for them, and making them so clear that he who ran might read. There ought to be an examination of some sort into novelty, and the least they could ask was information that the patent they were applying for was not anticipated by something already in the office of which they had no knowledge. There were six months' inventions sealed up, so that the public could not possibly know what the documents contained, and he considered they were very hardly used if a provisional specification was anticipated by something not accessible to them, and of which they were not informed. If there were to be examinations, there should also be analytical indexes, of the kind he had referred to over and over again; the specifications, as they came in, should be described by two or three lines of print, showing what they contained, or what they could not contain. This would greatly facilitate investigation, showing what need be looked into, and what might be passed over. In the original Patent Act there was a phrase indicating what was patentable matter, and he could not help thinking that at the time, and for many years afterwards, it was only inventions in use in the kingdom which would really anticipate a patent. By-and-bye, there came the printed documents, and the law courts considered that a printed document was a sufficient publication. Then came the specifications of foreign patents, and by that means the inventions which could be patented were much limited, because every American patent was sufficiently described immediately on the issue of the American patent. That being so, it was extremely important to insist on the clause which deferred for eighteen months the opera-

tion of a publication as affecting the validity of an English patent.

Mr. IMRAY said one of the great difficulties attending any improvement of the Patent-law was that so many persons interested in patents took such different views of what a Patent Act ought to be, and he feared his remarks would only throw down another apple of discord. It seemed to him that the difficulties about a Patent Act arose, not from any natural difficulty in the subject itself, but from a number of artificial difficulties which were put there on purpose to be got over. One was this. It was considered by the present law that the publication of an invention some years ago ought to stand in the way of a good patent for the same invention afterwards. He could not see why this should be at all; a patent for an invention was not for telling people how to do it, but for doing it, and, therefore, he should say, that actual use should be the only anticipation. It might often be very difficult, no doubt, to prove or to disprove prior user; but there was the same difficulty with regard to many other things, rights of way, ancient lights, and so on, but these things were proved, and he did not see why the same rule should not hold with regard to patents as with other property. An immense deal of difficulty again arose from the provisional specification, which he failed to see the use of. He thought no man should have a patent for an idea, but only for a developed invention. The way it worked was this. A man got a crude idea that he could do so and so, rushed to a patent agent, and made him draw a specification wide enough to cover every possible mode of doing the thing, and then he afterwards selected out of that what he finally specified. In his view, a man should mature his invention before he claimed a patent at all. All these differences about secret provisional specifications would vanish, if the provisional specification was done away with. Another question on which he differed with many people, was with regard to examinations. If it were possible, by any system of examination, either as to subject matter, novelty, or utility, to give a patentee an indefeasible right, examine by all means, but so long as the right remained just as questionable after, as it was before, what was the good of examination? the patentee got no benefit, nor the public either. Patent agents who had to take out patents in America, knew what difficulties they had to contend with there, the most frivolous objections being sometimes raised by the examiners. To give an example; a client of his invented a method of turning the slag for blast furnaces, by the addition of certain chemicals, into very excelient glass for bottles; he applied for a patent in America, and the objection raised was that in some book, 30 years old, there was this sentence, "the slag of blast furnaces is of a vitreous nature." The consequence was that in order to obtain an American patent, though the Government fee was only 17 dollars, there was so much difficulty and correspondence with agents abroad, sometimes extending over three or four years, in order to get over these frivolous objections, that the expense was greatly increased. And there would be the same thing here if examiners were introduced. To examine with any effect, they ought to have men as well qualified as Sir Frederick Bramwell. How were they to get such men and to pay them, and when they were found, what good would they be, if the patent was as questionable as before?

Mr. TWEDDELL said he had had a good deal to do with patents, and might say a few words from the patentees' and users' point of view. He was glad to find that Sir Frederick Bramwell had found so little to say in favour of the American system as being superior to our own. On the whole, he thought Sir Frederick's Bill stood out much better after Sir Frederick's visit to America than it did before. No less than 13 per cent. of the patents taken out in England in 1882 were by the Americans, 9 per cent. by Frenchmen, and 8 per cent. by Germans, which showed that even the law of 1852 was not very unfavourable to inventors. And it seemed to him that a great portion of the proposed Bill was only carrying ont the spirit of the Act of 1852, and in that view was to be highly commended. That Act contained the germs of all that was required for the protection of the inventor; it was true it had not been carried out, and he doubted whether it would be much better under the new Act. As to the antagonism felt to inventors, he had had a good deal to do with inventions, but he had never been robbed or insulted, though he had taken the bread out of the mouths of a great many men, as it was called. The change in opinion he attributed in a great measure to the paper read there some years ago by Sir Frederick Bramwell, which undoubtedly turned the tide in favour of patentees. But inventors, having been taken care of in their infancy, did not want to be molly-coddled and looked after too much when they were grown up; they would still have to go before the High Court of Judicature after they had gone through all the forms that this Bill provided. With regard to the improvement in the national resources by lowering the scale of fees, they had heard that if a few dollars had to be paid at the end of six years, 25 per cent. of the American patents would be swept away, which did not say much for the value of American patents as a whole; perhaps the same would apply to this country. No one could object to the scale of fees in the proposed Bill; his own experiences as a somewhat regular contributor of fees was that it would be a reasonable sum, and quite as little as any one could expect to pay and have anything for it. They heard a great deal about American patents only costing so much, but his own experience was that for a foreigner, having regard to all the circumstances mentioned by Mr. Imray, the expense was greater than that of obtaining a patent of

equal value in England. Added to that, you could get a good English patent, embracing six or seven different combinations, for each of which in America you had to take out a separate patent. Again, he remembered Mr. Imray stating that he could mention instances in which a man had sworn before the American Commissioners that he intended, at such a date, to patent an invention, and by that fact shut out another who had made the invention and wished to patent it. They were told that the amount of litigation in this country was really small; which proved that the present law, on the whole, worked well. He did not see that the examiners under the proposed Bill could do much harm, and if the Government took your money, it ought at least to see that your patent was not upset by a mere quibble.

Mr. James Wilson, like the previous speakers, had expected that the American system would have given more information how to reform our Patent-laws than appeared to be the case. The main points seemed to be that the American system was so much cheaper, that the patent lasted three years longer, and that there were examiners. Of course it was to be expected that the American system, having grown up from a positive grant of authority under the Federal constitution, would be free from many of the trammels which our own legal system gathered around the patentees; but it seemed to him that, after all, the English system, in practice, was not much inferior. He thought it an exaggeration to say that for the last thirty or forty years the inventor in this country was considered a public enemy; he did not think anyone outside a lunatic asylum would have said so from the time of George Stephenson. No doubt, in olden times, our Patent-laws having originated in Crown monopolies, the judges used to think that a patent right was against public policy, but that notion was soon got rid of. Political economists also, about the beginning of the century, considered that granting a monopoly was injurious to the public, but that notion had also disappeared, and for the last thirty or forty years, the inventor had been considered a public benefactor. It had been laid down by judges over and over again, that a benevolent interpretation should be given to a specification where the invention was a good and useful one; and so far from trying to trip up the patentee, they rather went out of their way to support the patent. The reform he thought most satisfactory was to reduce the initial cost of obtaining a patent, which no doubt the Society's Bill did. That being accomplished, it in great measure removed the necessity for examinations. To a poor man £145 was a prohibitive sum, if he were not sure that he would reap the benefit after all, and an examination which would prevent him incurring this great expense for nothing, would be a great boon; but if only a small sum were required, the inventor might take the risk. The history of patents disclosed several facts unfavourable to the system of examinations. He believed that in Germany both Bessemer's and Siemens's processes were refused a patent, and if this was done under an enlightened Government like the Prussian, he did not see how examination would prevent wrong being done. If examiners were appointed at all, he thought it would be necessary to have a large number, representing every branch of science, for it often happened that specialists were wonderfully ignorant of matters only just outside their own immediate subject.

Mr. Alfred Carpmael said Sir Frederick Bramwell had referred to several reports of the American Patent-office, but he might be pardoned for reading a few lines from one he had not mentioned, bearing on the position of inventors:—"No right can be more unquestionable than that resulting from discovery, unless it be that which is derived from actual creation. The recognition of either, if not instinctive in the brute, is certainly found in the lowest and most uncultivated orders of human intelligence. The bird seems to have a sense of the property in its nest; the beast in its lair; the savage certainly in the cave he has discovered, or the weapon he has made. Even the first occupant of a tract of land, which he has neither discovered nor created, has a title which, in the absence of a better, is protected by the Governments of all civilised countries. To none of these is the title of the inventor at all inferior. He has created or discovered all that he claims the right to possess. The property for which he asks protection might never have existed but for him who has created it out of nothing. At least, he has called it into active being, and made it the servant of mankind, subject to the limited right of ownership which he claims for himself. And when it is remembered that it is chiefly through the exercise of the inventive faculty that civilised man has risen above the savage, or that even the savage is to be distinguished from the brute, that it is the inventor who has either directly or indirectly been, and still is, the great instrument of human progress, that his has been the wizard-wand which has called forth from the latent powers of nature, messengers and servants, surpassing in fleetness, power, and mute obedience, the fabulous genii of Eastern tale, which has seized and freed as by enchantment the transient and varying lineament, or the flying sound, and transmitted them unchanged to posterity; or that in humbler but perhaps equally useful endeavour, he wears out his life in often unrequited efforts to benefit mankind, it must be a mistaken or perverted impulse which would grudge him that protection which is accorded to all others, or that would fail to encourage in all suitable ways, efforts from which the world is now reaping such incalculable benefits. . . . . The reason why hundreds of intellects in all parts of our country are strained to their utmost tension in the attempt to discover something that shall prove useful to mankind, is attributable to the fact that individual profit is incomparably blended with the general welfare. But who would cultivate a field

if others were to have an equal right to reap the harvest? The acknowledgment and protection of private property are the parents of industry, and effect as much in relation to inventions as to any other species of possession or estate." He felt great difficulty in making any remark in opposition to those of persons so experienced as Mr. Newton and the Vice-President of the Institute of Patent Agents, but he really could not follow Mr. Newton's objection to the examinations proposed by the Bill. Mr. Newton said there ought to be an examination into the most difficult subject of all, novelty; but he was quite certain Mr. Imray would object to that. They only proposed an examination into subject-matter — which, as Sir Frederick Bramwell reminded him, was supposed to be done now—whether the provisional specification indicated an invention of some sort, and whether the provisional and complete specification agreed together. It appeared to him that, to this extent, examination ought to be made. There was a great deal, no doubt, in Mr. Imray's suggestion to do away with the provisional altogether, but there was also a good deal to be said on the other side. No man could at once mature a complete invention; nothing but time and experiment would enable him to perfect it so as to be able to file a complete specification, and it was often impossible to keep these things secret. Unless he got provisional protection he ran the risk of some one running to the Patent-office with a so-called complete specification, which would be no more than a crude description of an invention, and ousting the real inventor of his patent. The last speaker said that political economists opposed patents, but he had found that one of the greatest of them, Mr. J. S. Mill, had recorded his opinion that the proper way to reward inventors was by granting patents, not to give them a public grant, because then those who used the invention would pay for it, and he further considered that an invention ought to be protected, and the inventor rewarded. He wished to point out the especial hardship of the present law with regard to foreigners, of which there had recently been an important exemplification. Nobody doubted who was the inventor of the phonograph, and under any proper law Mr. Edison would not have had to abandon that child of his; but because it had been held that he did not sufficiently indicate the nature of his invention in his provisional specification, he had had to disown that latest child of his genius. Sir Frederick Bramwell had expatiated on the position of an orphan invention found in the gutter; but what was the position of the phonograph? Discarded by its inventive father, declared illegitimate by the laws of the country, incapable by law of having any relations of any sort or kind, how long that poor invention would live but for the fact that its twin brother in America was still protected he did not know; but he feared that if it were not that Mr. Edison was still left to protect it in America, we should have heard no more of it. Yet he saw no reason to doubt that, in the immediate future, that which was now a mere toy would prove as useful to the community as its cousin, the telephone. To give another instance. A gentleman, named Wegmann, made an invention, which had revolutionised the whole milling system of the civilised world. After many years' experiments, he devised a system whereby he mounted cylinders of porcelain on rollers, and turned them up true; and by their means he produced the results of milling on semolina, middlings, and other products of grain, without any of the mischief which arose from the grinding operation of the millstones. The value of the invention was admitted, in a recent trial, to be upwards of £400,000 a year to this country, a large proportion of which was derived from what was previously a waste product, going away with the bran into the wash-tub. But because this gentleman was a foreigner, and there was no one to tell him, in the first instance, that he was not sufficiently clear, and no means of amending afterwards, the patent was lost to him in this country. The translation made was, "I coat rollers with china;" and the Court held that coating meant something in the nature of painting or enamelling, and as there was not sufficient information in his original patent, no amount of disclaimer could put any more in. He never thought of this case without a feeling of shame that our law was in that condition. He thought, therefore, they would all agree with the concluding part of an article in the leading journal of the previous Wednesday, that "it would be expedient in the new law that more tenderness should be shown towards the rights of inventors in the experimental stages of their labours."

Mr. RENOUF asked what was the opinion in America as to the practicability of carrying out an examination as to novelty? About ten days ago, on the occasion of an exhibition in Albert Hall, a meeting of manufacturers from Birmingham and Coventry was held to discuss changes in the Patent-law, when, finding that none of the gentlemen present were aware of the Society's Bill, he proposed that the meeting should be adjourned for a few days, in order that they might consider it. On doing so they came to the conclusion that it was as near perfection as possible, with the exception of this one point, as to which they thought it would be useless to have any examination at all if this point were excluded, as it was the one on which litigation principally turned. He should also like to know if he had interpreted the Bill aright, that if several persons applied for provisional protection for the same thing, each, without knowing of the other, within the six or nine months, their patents would run concurrently.

Mr. WOLSTENHOLME suggested that patents should be granted with a guarantee, and if the patent turned out invalid, the fees should be returned.

Mr. BROWNE said the cost of examination under

the American system brought up the expense very considerably.

The vote of thanks having been passed,

Sir FREDERICK BRAMWELL, in reply, said he was glad to have had the opportunity of hearing the opinions of two gentlemen so well entitled to speak as his friends, Mr. Newton and Mr. Imray, as well as those of Mr. Tweddell, and of Mr. Carpmael, who had assisted to draft the Bill. Some speakers had expressed surprise that he had not alluded more in detail to the American Patent-law, and that he had not as they said sufficiently shown the bearing of American law and practice upon the provisions of the Society's Bill, but the fact was he had shown that nearly every subject he had touched upon in connection with the Society's Bill was one in which it was either similar to the American practice, or was supported by American opinion, so that he had kept strictly to the title of his paper. The principal difference between them and the Americans was, the examination for novelty, and the reasons why this was excluded from the new Bill were the same as those he had advanced and had gone into very fully nine years ago. He was glad to hear Mr. Imray's instance of the dangers attendant on an examination for novelty. It was a scandal that a patent should be refused on ground of want of novelty by such a circumstance as had been mentioned. He remembered pointing out in that room, that if James Watt had gone before examiners who knew of Smeaton's engine, on a question of novelty and utility, he would not have got his patent. They would have told him that he was coming for a patent for condensing in a separate vessel, and drawing out the water by means of a common pump; that he had only added a complication to Smeaton's engine, and that there was nothing novel except that which was useless. Yet all the civilised world honoured Watt for that very invention, which he was quite sure would not have passed muster before an examiner for novelty and for utility. He had listened with the greatest respect to the opinion of gentlemen who doubted the propriety of the examinations which the Society's Bill proposed, but after full consideration, he still adhered to his opinion that in so far as it was possible to ascertain whether a patent were valid or not, it should be ascertained. Now there were certain matters which were easily ascertainable by examiners, and it was in respect of these matters that the Society proposed there should be examinations. Such were subject-matter. Why should they not also examine whether the agreement between the provisional and the title, and the agreement of the complete specification with the provisional was satisfactory? Why, as in the case of the phonograph, was Mr. Edison to be allowed to get a patent for it, and then, when an action was brought, not on the phonograph, but on another matter, should the defendant be entitled to say, "I object to the validity of the patent, because some one thing is beyond that for which the Provisional Protection was originally granted." The judge said, reading the Provisional Specification, "I do not find foreshadowed there that which is the subject of the phonograph, and, therefore, I declare the patent bad." Why should not Mr. Edison have been told that when the patent was applied for? These things could be determined with very little doubt, and the patentee could then say, "If it is not within the provisional, I will incur the expense of a second patent; I will not imperil my phonograph by including it where it ought not to be. Such examinations as these might do a great deal of good, and were not likely to do any harm to the applicant, but even this was provided against by the granting of an endorsed patent. He could not go at so late an hour into the question of the effect of examinations into novelty in America, but would refer to his previous paper in vol. xxiii. of the *Journal*. The Americans had not adopted the endorsed patents but one of their reports approved of the system. After going through the various points in which the proposed Bill was supported by American practice or opinion, Sir Frederick Bramwell said that he was warranted in affirming that, in at least eight points out of ten, the new provisions of the Society's Bill were justified by what was already done or was wished for in America, and without servilely bowing down before any other country, he did think they would be warranted in saying before a Parliamentary Committee,—We ask you to attach a value to these proposals, because they accord with what is done in a country which is before any other in the way in which it has dealt with inventors. Mr. Brown had referred to the extra cost of the examinations, but it was not proposed that there should be any charge made to the inventor. As Mr. Carpmael reminded him, the Bill provided, in Clause 50, for making proper abridgements of the specifications, as referred to by Mr. Newton.

Correspondence.

CAST IRON AND WROUGHT IRON EXPOSED TO SEWAGE.

Town sewage, that is, waste-water and human excreta, does not act injuriously on iron. In the manufacturing districts of Lancashire and Yorkshire, sewage is even most extensively used for steam-boiler purposes, the boilers, however, having special arrangements for blowing out mud. Sewage does not fur the boilers, and is consequently preferred to clean but hard water. Sewage contains solutions of soap, oil, and fatty matters, which tend to protect iron. Cast-iron pipes may be jointed with Portland cement in place of lead, making, in fact, the strongest joint known. At Chatsworth, the cast-iron pipes for the Emperor Fountain are jointed with Portland cement.

C. B.

SUEZ CANAL STATISTICS.

In the brief report, in the *Journal* for Jan. 27 (p. 211) of my remarks on the political aspect of the Suez Canal and its control, there is an inaccuracy which—though it may be my fault—I crave leave to correct, because of the present unsettled position of that important question. After the remark, that each country "had an interest in proportion to its trade," I am made to say, "that was an additional reason why the control and protection of the Canal should rest with England"—alone. Not so. I was trying to point out that, because traffic through the Canal is an international interest, it is neither just nor expedient to insist too strongly on the desire expressed towards the close of General Rundall's paper, that "England should keep the key of the Water Avenue that leads to her Eastern Empire;" for, although our share of the trade happens to be the largest, it is still the trade of the *whole* commercial world that has to be considered. To Italy, and to Austria (*i.e.*, all Southern Germany), to say nothing of France, their share in the trade through the Canal is as important to *them*, or more so, than our share is to rich and powerful England. Therefore, though they may, because of our power, be willing to see "the key of the Water Avenue" between Europe and Asia entrusted to England's keeping, they have a right to ask that the position accorded to us shall be that of a trustee, and not that of a domineering rival. The custody of the Canal must be settled on a basis that is just, in order that it may be durable; and, from first to last, jurists will maintain that as the Canal is in Egyptian territory, it is Egypt that must give the mandate for its security.

The statistics of Indian trade so usefully appended to General Rundall's paper stop short with the year 1880-1; and as that is only up to March 31st of the latter year, there remains a considerable hiatus, inasmuch as the close of the official year 1882-3 will soon be here. It appears to me that the value of those statistics already given will be much enhanced for purposes of comparison if the figures of 1881-2 are added, and as these are within my reach, I will add them—that is, I will give most of the totals for that year.

TABLE I.—VALUE OF IMPORTS INTO INDIA FROM ALL PORTS, INCLUDING TREASURE, IN THE YEAR 1881-2.

	£
Total merchandise	46,991,655
Proportion by Suez Canal	37,683,990
,, ,, other routes	9,307,665
Per-centage by Suez Canal	80·92
,, ,, other routes	19·08
Total treasure or bullion	11,322,780
Proportion by Suez Canal	5,477,507
,, ,, other routes	5,845,273
Per-centage by Suez Canal	48·37
,, ,, other routes	51·63
Total merchandise and bullion	58,314,441
Proportion by Suez Canal	42,161,490
,, ,, other routes	16,152,951
Per-centage by Suez Canal	72·30
,, ,, other routes	27·70

TABLE II.—VALUE OF EXPORTS FROM INDIA, INCLUDING TREASURE, TO ALL PARTS IN THE YEAR 1881-2.

	£
Total merchandise	81,899,920
Proportion by Suez Canal	42,751,172
,, ,, other routes	39,148,757
Per-centage by Suez Canal	52·20
,, ,, other routes	47·80
Total treasure or bullion	1,099,746
Proportion by Suez Canal	95,586
,, ,, other routes	1,004,160
Per-centage by Suez Canal	8·70
,, ,, other routes	91·30
Total merchandise and bullion	82,997,205
Proportion by Suez Canal	42,846,760
,, ,, other routes	40,150,545
Per-centage by Suez Canal	51·62
,, ,, other routes	48·38

TABLE III.—AGGREGATE TRADE OF INDIA FOR 1881-2.

	£
Total merchandise exported and imported from all parts and by all routes	128,891,574
Proportion by Suez Canal	80,425,162
,, by other routes	48,456,412
Per-centage by Suez Canal	62·46
,, by other routes	37·60
Total treasure and bullion	12,420,166
Proportion by Suez Canal	5,573,094
,, by other routes	6,847,072
Per-centage by Suez Canal	44·86
,, by other routes	55·14
Aggregate trade, merchandise and treasure	141,311,740
Proportion by Suez Canal	86,008,256
,, by other routes	55,303,484
Per-centage by Suez Canal	60·86
Per-centage by other routes	39·14

TABLE VI.—TOTAL QUANTITIES AND VALUES OF THE FOLLOWING ARTICLES OF INDIAN PRODUCE AND MANUFACTURE EXPORTED FROM BRITISH INDIA, IN THE YEAR 1881-2.

		£
Coffee	cwts. 346,401	1,447,615
Cotton, raw	,, 5,628,898	*14,939,515
Indian made twist	lbs. 30,786,304	1,368,836
,, ,, piece goods	yards 29,911,016	556,400
Rice	cwts. 28,487,649	8,244,107

* Of which to United Kingdom—2,781,642 cwts; value £7,244,357.

			£
Wheat	„	19,863,520	8,604,081
Raw hides & skins	„	566,185	1,810,350
Dressed „	„	249,025	2,138,442
Jute, raw	„	7,510,314	5,030,302
Saltpetre	„	354,860	359,436
Seeds	„	10,466,098	6,054,098
Tea	lbs.	48,691,725	3,609,136

It is desirable to point out that General Rundall has omitted one not very considerable, but rather significant factor from his figures of the Indian trade; that is, the item of Government stores and treasure. Doubtless General Rundall had some good reason for this omission, therefore I have taken the same course in my entries of all figures for 1881-2. The amounts in Government shipments are not large, varying from about one and a-half to rather over two millions of merchandise imports into India, and under half a million worth of exports. By far the larger part of these Government shipments do pass through the Canal; and also all the official exports of treasure from India, which are insignificant in amount, the largest, I notice, being £106,000 in 1879-80.

One more, and rather an important consideration affecting the figures of value as taken out by General Rundall is, that they are taken in the old ready way of reckoning ten rupees to the pound sterling, and not, as the *Economist* and some other statistical writers now count, namely, at twelve rupees to his pound. I have taken the ten for uniformity sake.

W. Martin Wood.

West Kensington, Jan. 29.

General Rundall communicates the following tables which were used as diagrams on the wall at the meeting, and should have been printed with his paper:—

Table showing Traffic on Suez Canal from 1870 to 1881 inclusive.

Year.	No. of Ships.	Gross Tonnage.	Gross Receipts.
			£
1870	486	435,911	255,488
1871	765	761,467	464,091
1872	1,082	1,439,169	758,659
1873	1,173	2,085,073	971,882
1874	1,264	2,423,672	1,029,492
1875	1,494	2,940,709	1,204,387
1876	1,457	3,072,107	1,229,157
1877	1,663	3,418,950	1,337,617
1878	1,593	3,291,535	1,272,435
1879	1,477	3,236,942	1,214,443
Total, 10 years	12,454	23,105,535	9,739,651
1880	2,026	4,344,519	1,672,836
1881	2,727	5,794,401	2,187,047

Table showing the Relative Nationalities of Ships traversing the Suez Canal in each of the Years 1879-81.

Nationalities.	1879.			1880.			1881.			During the 10 years 1870-79.	
	No. of Ships.	Gross Tonnage.	Per cent.	No. of Ships.	Gross Tonnage.	Per cent.	No. of Ships.	Gross Tonnage.	Per cent.	No. of Ships.	Gross Tonnage.
German	16	21,548·44		38	52,557·11		45	59,515·31		223	286,678
English	1,144	2,508,524·75		1,592	3,446,431·42		2,251	4,792,117·80		9,154	17,555,497
Austrian	40	71,400·03		60	103,030·20		64	115,776·80		522	662,992
French	93	262,017·90		102	271,598·19		109	289,324·12		831	1,999,014
Italian	52	94,162·33		52	104,567·36		52	113,252·40		495	610,088
Dutch	61	159,024·89		70	174,485·15		71	187,910·19		423	955,484
All others	71	120,263·94		112	191,850·50		135	236,504·57		806	1,043,778
	1,477	3,236,942·28		2,026	4,344,519·93		2,727	5,794,401·19		12,454	23,163,535
Per cent. of British Vessels	77·4		77·4	78·5		78·5	82·5		82·7	73·1	76·00
French do.	6·3		8·09	5·0		6·25	6·2		5·0	6	8·7

SANITARY INSPECTION OF HOUSES.

Mr. W. Hempson Denham suggests that the scheme of sanitary inspection of houses should be extended, so as to include furnished houses and lodgings, where patients suffering from infectious diseases, such as small-pox, scarlatina, diphtheria, and typhoid may have lived. He writes: "There is no sanitary inspection to secure the next comer from disease, nor is it likely that security will be given, unless Government provide it, free from all local influence. The fact is, there is no standard of sanitary truth in existence to judge by, and people are fast losing faith in the contradictory dogmas of what is called sanitation, and the doings of incompetent sanitary engineers."

In your issue of the 2nd inst., Mr. Cresswell says, in regard to my suggestions, "All these points may now be taken for granted, as I have been myself parent or sponsor to each one of them." As a fact, my views were known to many, several years ago; but being stationed in an obscure corner of the kingdom, I had no opportunity, until my recent retirement from office, of bringing them forward; and I may add that, prior to the reading of Mr. Burton's paper, and before I could know the views of Mr. Cresswell, or any one else on the subject, I had practically carried out my own as far as I could, but at my own expense. Capt. Douglas Galton also says that my "suggestion is a very valuable one, but it is not new;" to which I reply, possibly not, though still my own, as stated above; and yet (so far as I am aware) the most practical part, with reference to the Local Government Board responsible examinations and certificates of competency, &c., as well as a provision for cost of survey, without increasing the rates, may be so. I would further observe that the suggestions I have advanced merely form the outline of a scheme which, as I said in the concluding part of my former letter, I shall be only too glad to see taken in hand, and probably improved by those who have more power to act in the matter than myself, for the subject is one of national importance, as many a sorrowing household (especially among the upper and middle classes) can testify; and as I fear no private interest is sufficient to cope with it, I venture to propose that a select committee of the most influential members of the Society of Arts should frame a concise and well-digested plan for the consideration of the Local Government Board, and that subsequently a deputation should wait upon that Board for the purpose of discussing and bringing the matter to a final issue.

A few words with reference to an observation by Mr. Liggins on Mr. Burton's paper, viz., "He believed that water-closets and drains did not generally communicate with the drinking water." Here is my experience, and doubtless that of many others on that subject:—Suffering, with my household, from the usual symptoms of sewer-gas poisoning, I called in the aid of one of the smartest inspectors of nuisances in one of the largest suburban parishes, who, after inspection, remarked that the house was exceptionally clean and in good order, and that there was no bad smell, when I ventured to observe that comparatively inodorous gases were said to be the most dangerous, at which he expressed surprise. I then went over the house with him again, and pointed out that the servants' water-closet, in the lower hall, ventilated under the floor of the housemaid's closet and the dining-room above, and that each of the others ventilated under the flooring of the respective bedrooms overhead. We next examined the water-cistern, and when I pointed out a large waste-pipe in the centre of it, communicating directly with the main sewer below, he merely remarked, "I know of hundreds like that!" Comment is needless.

JOHN WM. WOOD, H.M.C.S.

34, Great St. Helen's.

HYDRAULIC MACHINERY.

My attention has been drawn, by Mr. Duer, to an error in the published account of my lectures on "Hydraulic Machinery," delivered March 27th, 1882. Messrs. Clark and Standfield there get the credit of designing the Anderton hydraulic lift, whereas the firm of Clark and Standfield was not in existence when the lift was designed. I now understand that Mr. Edwin Clark, who is a partner in the above firm, was the engineer consulted on the subject, and that he entrusted Mr. Duer with the arrangement of the details under his own supervision and that of the engineer of the Weaver Trust.

JOHN PERRY.

10, Penywern-road, South Kensington, S.W.

THE TECHNICAL ASPECTS OF LIGNIFICATION.

I did not go into details in referring to the processes of esparto boiling; it is, I believe, more usual to boil with, than without, pressure, and I mentioned Mr. Routledge's name rather in its general connection with the process which has now grown to a standard method. I would point out that the apparent similarity of the various sulphite processes of wood boiling to one another, and to the original Tilghman process, is probably less remarkable than their specific differences. Lastly, I should be very glad to have samples of white writing-papers made entirely from wood pulp prepared by the caustic soda process. I have tried, but without success, to procure such, and the experience acquired in the search led me to the conclusion that this pulp occupies a position of inferiority, already admitted.

CHARLES F. CROSS.

Obituary.

Miss Fanny Corbaux, the artist, who died on February 1st, at the age of seventy-one, was an honorary member of the Society of British Artists, and a member of the Institute of Painters in Water Colours. In 1827, she obtained the large silver medal of the Society of Arts for an original portrait in miniature; and in 1829, the silver Isis medal for an original historical composition in water colours. In 1830, she was awarded the gold Isis medal, again for an original portrait in miniature.

General Notes.

Exhibition of Meteorological Instruments.—The Council of the Meteorological Society have arranged to hold an exhibition of meteorological instruments, which have been designed for or used by travellers and explorers, on the evening of March 21st, at the Institution of Civil Engineers, Great George-street, Westminster.

School of Art Wood-carving.—Free Studentships in both the day and evening classes of the School of Art Wood-Carving are at present vacant. Candidates should have passed the examination of the Science and Art Department in Second Grade Free-hand Drawing, and should be persons who are intending to earn their livelihood by Wood-Carving. Forms of application and copies of the prospectus of the school may be obtained on application to the manager, School of Art Wood-Carving, Royal Albert Hall, Kensington, S.W.

Goldsmiths' Company's Prizes. — The programme of prizes for the twelfth competition, offered by the Goldsmiths' Company with a view to the encouragement of Technical Education in the design and execution of works in the precious metals, has just been issued. The prizes will consist of one of £70, one of £50, four of £35, one of £30, seven of £20, three of £15, and three of £10. The Company have also resolved that a Travelling Scholarship of £100 may be awarded by the Wardens to a student who has shown exceptional talent, and who shall have obtained prizes for design or modelling in three years' competitions, in order to enable him to study art in the precious metals on the Continent of Europe.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock :—

February 21.—"Recent Improvements in Agricultural Machinery." By D. Pidgeon. Sir Frederick Bramwell, F.R.S., will preside.

February 28.—"The Increasing Destruction of Life and Property by Fire. What is the Remedy?" By Cornelius Walford.

March 7.—"The History of the Pianoforte." By A. J. Hipkins. John Stainer, M.A., Mus. Doc., will preside.

Foreign and Colonial Section.

Tuesday evenings at 8 o'clock :—

February 27.—"Egypt, Present and to Come." By Robert W. Felkin.

March 20.—"Social and Commercial Aspects of New Zealand." By William Delisle Hay.

Applied Chemistry and Physics Section.

Thursday evenings at Eight o'clock :—

February 22.—"Some Causes of Fires and Methods for their Prevention." By Walter G. McMillan, F.C.S. Captain Eyre Shaw, C.B., Chief Officer, Metropolitan Fire Brigade, will preside.

March 8.—"Self-purification of River Waters." By W. N. Hartley, F.R.S.E.

April 12.—"The Formation of Diastase from Grain by Moulds." By R. W. Atkinson, B.Sc.

Indian Section.

Friday evenings at Eight o'clock :—

March 2.—"Agriculture in Lower Bengal: with some Notice of Tenant Right, &c." By W. S. Seton-Karr. The Honourable Sir Ashley Eden, K.C.S.I., will preside.

April 6.—"Private Enterprise in India." By J. M. Maclean.

April 20.—"Fisheries of India." By Surgeon-General Francis Day.

May 4.—"Some Notes on the Domestic Architecture of India." By C. Purdon Clarke.

May 25.—

Cantor Lectures.

Monday evenings at Eight o'clock :—

Second Course, on "Solid and Liquid Illuminating Agents." By Leopold Field.

Lecture IV.—February 19.

Secondary, or manufactured products. Chevreul's discoveries. Fatty acids; their formation by saponification, distillation, and pressure. Glycerine. Collateral benefits accruing from the Palm oil trade.

Lecture V.—February 26.

Paraffin. History and sources. Outlines of the chief processes of manufacture. Coal-tar products. Paraffin oil. Naphtha. Petroleum.

LECTURE VI.—MARCH 5.

Ozokerit, and other mineral sources of light. Manufacture of Candles. Survey of the candle trade and the various inventions and industries excited hereby. Conclusion.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Leopold Field, "Solid and Liquid Illuminating Agents." (Lecture IV.)

Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. A. T. Walmsley, "Land Surveying and Levelling." (Lecture VI.)

Institute of Surveyors, 12, Great George-street, S.W., 8 p.m.

British Architects, 9, Conduit-street, W., 8 p.m. Mr. R. H. Carpenter, "A Comparison between the Mosque-Cathedral of Cordova, and some other Contemporary Arabic Buildings."

Medical, 11, Chandos-street, W., 8¼ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m. 1. Mr. Hyde Clarke, "The Relations of the Languages of India and Africa." 2. Professor Gustav Oppert, "Gunpowder and Fire-arms among the Ancient Hindus."

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Surgeon-General C. Gordon, "Life and its Manifestations in Man and in the Lower Animals."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Alfred Tylor, "Æsthetics of Nature, as Displayed by Plants and Animals."

TUESDAY, FEB. 20...Royal Institution, Albemarle-street, W., 3 p.m. Professor R. S. Ball, "The Supreme Discoveries in Astronomy—The Scale on which the Universe is Built." (Lecture I.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on Paper by Messrs. Thomas Bell Lightfoot and John Thompson, "The Design and Construction of Reparing Slipways for Ships." 2. Mr. William Morris, "Covered Service Reservoirs."

Statistical Society, at the Museum of Practical Geology, Jermyn-street, S.W., 7¾ p.m. Mr. Arthur Ellis, "The Parliamentary Representation of the Metropolitan, Agricultural and Manufacturing Divisions of the United Kingdom, with Suggestions for its Redistribution."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. Sclater, "Birds from Timor Laut, collected by Mr. Henry O. Forbes." 2. Professor J. Jeffrey Bell, "Some New or Rare Species of Echinodermata." 3. Dr. Hans Gadow, "The Lingual and Hyoid Apparatus of Birds." 4. Dr. Hans Gadow, "Some Points in the Anatomy of the Laniidæ, Paridæ, and Tenuirostres."

WEDNESDAY, FEB. 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. D. Pidgeon, "Recent Improvements in Agricultural Machinery."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. G. Wareing Ormerod, "Note on a Remarkable Land Fog Bank, 'The Larry,' that occurred at Teignmouth, October 9th, 1882." 2. Capt. J. de Brito Capello, "Barometric Depressions between the Azores and the Continent of Europe." 3. Capt. Campbell M. Hepworth, "Weather Forecasts and Storm Warnings on the Coast of South Africa." 4. Prof. E. Douglas Archibald, "Note on the Reduction of Barometric Readings to the Gravity of Latitude 45°, and its Effect on Secular Gradients."

Geological, Burlington-house, W., 1 p.m. 1. Mr. E. A. Walford, "The Relation of the So-called 'Northampton Sand' of North Oxfordshire to the Clypeus Grit." 2. Mr. D. Mackintosh, "Results of Observations, in 1882, on the Positions of Boulders Relatively to the Underlying and Surrounding Ground, in North Wales, North-West Yorkshire; with Remarks on the Evidence they Furnish of the Recency of the Close of the Glacial Period." 3. Mr. G. R. Vine, "Notes on the Corals and 'Bryozoans' (Hall, Ulrich, &c.) of the Wenlock Shales (Mr. Maw's Washings)."

Royal United Service Institution, Whitehall-yard, S.W., 3 p.m. Capt. N. L. Walford, "The Effects of the Bombardment of the Forts of Alexandria, and the Lessons to be learnt therefrom." (Part II.)

Archæological Association, 32, Sackville-street, W., 8 p.m. Mr. William Rendle, "Southwark in Roman Times."

Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Gulstonian Lectures.) Dr. J. M. Duncan, "Sterility in Women." (Lecture II.)

THURSDAY, FEB. 22... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Mr. Walter G. McMillan, "Some Causes of Fires and Methods for their Prevention."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Professor W. E. Ayrton, "Electric Lighting and Locomotion." (Lecture I.)

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Emil Behnke, "The Human Voice as a Musical Instrument; its Mechanism and Management."

Royal Institution, Albemarle-street, W., 5 p.m. Prof. Dewar, "The Spectroscope and its Applications." (Lecture VI.)

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

FRIDAY, FEB. 23...Royal College of Physicians, Pall Mall East, S.W., 5 p.m. (Gulstonian Lectures.) Dr. J. M. Duncan, "Sterility in Women." (Lecture III.)

Royal United Service Institution, Whitehall-yard, 3 p.m. Lieut. Berkeley Piggott, "The Mounted Infantry in Egypt."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. W. H. Pollock, "Sir Francis Drake."

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, FEB. 24...London Sanitary Protection Association (at the HOUSE OF THE SOCIETY OF ARTS), 4 p.m. Annual Meeting.

Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. Lewis Wright, "Optical Combinations of Crystalline Films." 2. Mr. Philip Braham, "Experimental Demonstration of the Vertical Theory of the Formation of a Solar System."

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. H. Stone, "Singing, Speaking, and Stammering." (Lecture II.)

Journal of the Society of Arts.

No. 1,579. Vol. XXXI.

FRIDAY, FEBRUARY 23, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The fourth lecture of the course on "Solid and Liquid Illuminating Agents," was delivered by Mr. Leopold Field, F.C.S., on Monday evening, February 19th. The lecturer explained the effect of Chevreul's discoveries in the improvement of the manufacture of tallow candles, and referred to the purification of glycerine by a process invented by Mr. G. F. Wilson, F.R S. The last part of the lecture was devoted to an account of the treatment undergone by palm oil, to fit it for candle-making.

The lectures will be printed in the *Journal* during the summer recess.

SOCIETY OF ARTS' PATENT BILL.

The Patent Bill of the Society of Arts has been re-introduced into the House of Commons by Sir John Lubbock, Mr. William Henry Smith, and Mr. J. Lawrance, and was read a first time on Monday, the 19th inst. The second reading is fixed for Tuesday, the 27th inst.

Mr. Chamberlain, President of the Board of Trade, has brought in the Government Patent Bill, which was also read on the 19th inst., and the second reading fixed for Monday, the 26th inst.

PREMIUMS FOR THE 129th SESSION.

The following prizes are offered by the Council for the year 1883:—

John Stock Prize.—A Society's Gold Medal, or £20, for the best design from a poem, or from history, or from the Scriptures, prepared with a view to Mural Decoration.

Benjamin Shaw Prize.—1. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the operations of coal-mining." 2. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the manufacture, storage, and transport of explosives."

The Council leave it to the competitors to bring the plans under their notice in any way they may think proper, whether by model, written description, or otherwise.

Howard Prize.—A prize of £100 for the best Essay on the Utilisation of Electricity for Motive Power. Preference will be given to that essay which, besides setting forth the theory of the subject, contains records with detailed results of actual working or experiment. The Society reserves the right of publishing the prize essay.

Fothergill Prize.—A Society's Gold Medal, or £20, is now offered for the best Invention having for its object the Prevention or Extinction of Fires in Theatres, or other places of public amusement.

Mulready Prize.—A Society's Gold Medal "To that student in a School of Art in the United Kingdom who exhibits the best Drawing from the nude figure, executed in black and red chalk, in the manner so successfully practised by Mulready."

Designs, plans, models, essays, descriptions, inventions, &c., intended to compete for any of the above Prizes, must be sent in on or before the 31st October, 1883, to the Secretary of the Society of Arts, John-street, Adelphi, London.

Further particulars relating to the Prizes will be found in the number of the *Journal* for February 2, or may be obtained on application to the Secretary.

Proceedings of the Society.

INDIAN SECTION.

Friday, February 16th, 1883; Sir Rutherford Alcock, K.C.B., in the chair.

The paper read was—

THE OVERLAND ROUTE TOWARDS CHINA FROM INDIA *VIA* ASSAM.

By Charles H. Lepper, F.R.G.S.

I have been asked to read a paper before this Society upon a subject I have taken the

greatest interest in for ten years, viz., the question of an overland route towards China *viâ* Assam.

As I have already entered at some length into the geographical side of the question, in papers I have had the honour of reading before the Geographical Section of the British Association at Southampton, and the Asiatic Society of Bengal, at Calcutta, I purpose in this paper dealing more particularly with details to which I have hitherto done scant justice, and I shall confine my remarks on the geographical side to those of a purely introductory character. Briefly then, let me point out the position of Assam, as regards its bearing in the cause I am advocating. Assam, formerly under the Lieut.-Governor of Bengal, but now under its own Chief Commissioner, runs up like a tongue from Gangetic India, and ignoring for the moment the intervening hill-savages, may be said to separate Thibet from Burmah, whilst its point rests, as it were, on neutral ground, which latter again touches China. It is with this neutral ground my scheme of exploration exclusively has to deal.

Fine river-steamers, belonging to three different companies, to which a fourth company (of daily steamers) is about to be added, run several times a week from Calcutta to Dibrugarh, and from Dibrugarh a line of railway is under construction to Makum, which line is to be completed in July, 1883, and will then allow us to say that we have steam communication all the way from Europe to our very extreme frontier nearest to China. In fact, we shall have steam communication to within 150 miles of Maingna (on the upper portion of the River Irrawaddi) to which locality Chinese traders already come. The Chinese traders who have crossed their own frontier to come so far towards us—and they have been seen within forty miles of our frontier at Bisa—for the sake of the purely local trade they now find, are only prevented from coming the short remaining distance to us at Makum owing to the old routes—formerly in extstence, when Assam was under the Burmese rule—having been allowed to close themselves by neglect, and the consequent over-growth of jungle.

As among the advantages of opening these old routes I claim the possibility of thereby creating a trade with Eastern Thibet, it may be as well first of all to explain why I should think of such an apparently round-about way of conveying merchandise into Thibet. I do not speak of the passage of Europeans, but of European goods.

The proverbial school-boy knows that all our efforts to open communications direct with Thibet have failed, and Thibetan exclusiveness has become a by-word. But, until the causes for such exclusiveness are realised and thoroughly understood, such a field for adventure must continue to tempt many, and dreams will be entertained that, although others may have failed, that is no reason why somebody else should not succeed. Let me then give some of the reasons for this Thibetan exclusiveness, and then, when it is realised that probably nothing short of a total separation of Thibet from China, or at all events a total upsetting of all the established order of things as at present existing in Thibet, will admit of a change of policy, so necessary as the present policy is to the maintenance of the established order of things, perhaps it will be admitted that, for some time to come, not to be too prophetic by putting a date to it, we can hardly expect any opening of Thibetan doors to Europeans.

I regret I have not time to enter into a full, detailed account of what might perhaps be called the triarchical system of government of Thibet, as I should like to do. Had I been able to do so, it would facilitate the appreciation of the full scope of the reasons I shall give to account for Thibetan exclusiveness; and without a fair conception of the system of government, a great deal of the weight of the reasons is not apparent by their mere assertion.

In Thibet, there are two distinct administrations, the Chinese and the Thibetan. The Thibetan, again, is divided, as the Ta-li-lama is the virtual owner of Thibet, and the King is not. Thus the owner, so to speak, is the spiritual head. There are at the head of affairs, besides the King and Ta-li-lama, the three Chinese Delegates or Residents, through whom all correspondence with the Emperor of China must pass, neither the King nor the Ta-li-lama being allowed to correspond direct with the Emperor. Besides the three Delegates or Commissioners, there are, of course, subordinate grades of Chinese officials, and a Chinese "army of occupation" of some 4,000 men. Apart from the Chinese Administration, the Thibetan Administration has its own grades of officers, and also an armed body of men, which cannot be dignified with the name of an army. The Thibetans hate the Chinese officials, and say that the latter come to their country beggars and grow rich

at the expense of the country. The people of Thibet are indeed simply considered by the official classes as the wealth-suppliers of the Lamas, and of the Chinese and Thibetan officials. The Lamas have been said to form nearly a quarter, if not more, of the entire male adult population. This means that a quarter of what might be bread-winners are drones, and living by the labour of others. When we consider that these "drones" are not content with necessaries of life only, but require luxuries, and have powers which they do not fail to use in their efforts to extort from the people the full measure of their wants, it is hardly conceivable that such a state of things can be permitted to exist by any people in the world. Yet, on the top of all this, we have the Chinese and Thibetan officials and their exactions!

The Chinese Government makes little, if anything, pecuniarily out of Thibet; but the officials it sends there (generally its worst, under punishment, as Thibet is a sort of Siberia to Chinese officials) amass fortunes for themselves.

By the peculiar arrangement of the system of government, the Chinese can at any moment lay all blame on the Thibetans for any hostile act against Europeans, or for any obstruction they may have thrown in the way of the latter; whilst at the same time the Chinese Government may, and probably have, given the very orders which brought about the act of hostility or obstruction. Thus whilst apologising at Pekin for some Thibetan obstruction, the very orders for such obstruction probably emanated from Pekin. As an instance of this sort of double-dealing, whilst Sir Thomas Wade was arranging the treaty or convention, by certain clauses of which Europeans were to be allowed to travel in China, the Chinese Government agreeing to these clauses, at the same time despatched two special Commissioners to the Thibetan frontiers, with express orders to see that the frontiers were extra well guarded, especially those adjoining Boutan and Sikhim! Had an attempt been made to enter Thibet by, let me say for the sake of argument and with all respect, a Sir Richard Temple, even he would have been turned back; the Chinese Government, if appealed to, would have protested its sorrow, and would have regretted the obstructiveness of those barbarian Thibetans! That the above orders were sent, I have on the authority of one I cannot doubt. But this is only an instance of obstruction of which I could give more astonishing examples still, some, for example, connected with the Count Szechengi expedition which would probably even surprise the Count himself; but my time being limited, I must come to the reasons or causes for this obstruction.

Formerly, Mongolia, the Corea, Japan, Cochin China, Siam, Burmah, and Thibet were all tributary to China, and sent ambassadors to Pekin to acknowledge their dependence. Thus China was completely surrounded by a chain of smaller tributary States, and this fact helped to establish the belief that the Emperor of China was Emperor of the whole world, as even now represented in popular editions of Chinese maps, on which China occupies nearly the whole sheet, leaving Japan, the Phillipines, and Europe to be represented by small dots. These maps are accepted and thoroughly believed in by the people in the interior of China. The belief that the Emperor of China rules the world, so earnestly propagated by the Chinese officials, found additional support from the fact of European ambassadors being sent to Pekin; these being understood by the people to be sent, like the ambassadors of the tributary States already mentioned, to pay respect and do homage to the Chinese Emperor. It was further supported until lately by the fact that no Chinese ambassador had to go to any foreign Court, and even now they have only one for several States; and this much renders the Mandarins of the interior furious to think of (*i.e.*, those of the old school, with all its credulity and ignorance), as they cannot understand such a stooping to "barbarian" Powers.

In later times, Japan, Cochin China, Siam, and Burmah have either wholly or practically thrown off their allegiance, and no longer pay tribute. They now rarely (some of them never) send ambassadors with presents to Pekin. This, as a natural consequence, is attracting attention, and is commencing to prejudice the belief in the Emperor of China as ruler of the world; and yet this belief is a part, apparently, of the Chinese nature, and almost a necessity to the tranquility of that peculiar country, and to the stability of the throne.

Quite recently, the Chinese Government have sent demands to Siam, claiming the resumption of the payment of tribute by that State.

The Pekin officials fully realise that the loss of these States is owing, in a great measure, to the influence of Europeans since their arrival and settlement in those parts. Natur-

ally, then, they fear that if Europeans enter and settle in the Corea and Thibet, the same thing would happen in those countries, and so we see a similar game of obstruction played in both. They specially dread the entry of Europeans into Thibet, where, it is well known, there is a very strong party, numerically speaking, antagonistic to the present Chinese rule, and desiring autonomy. The people of Thibet, too, are quite different from the Chinese in character, and cannot agree with the latter. Again, the Thibetans are tired of seeing all the Chinese Mandarins sent to Thibet reaping large private fortunes out of the country, against which the sums spent by the Chinese Government on the soldiery and Lamas, divided in infinitesimal portions amongst many, are by no means considered as even a partial set-off.

As a matter of fact, the Chinese Government does not derive much pecuniary gain from Thibet, say only a few thousands of pounds, levied chiefly in duties at Ta-tsien-lu; still it is a mine to the Chinese officials, even though it may be actually a burden, pecuniarily, to the Chinese Government. The burden, however, is compensated for by having another dominion in the empire, for the sake of prestige, and this is really why China is so jealous of European enterprise entering Thibet. It should also be remembered that, through the occupation of Lhassa as the centre of "Lamaism," or Northern Buddhism, and the derivation of the Taranath Lama from that "holy" city, China controls the whole of Mongolia, or at least, exercises a dominant religious influence over it.

Now let me tell you a Thibetan story:—

At the end of the last Chinese dynasty, there occurred a civil war in China against that dynasty, the partisans of which called in to their assistance a celebrated Manchu general. This general, some years before, had had his fortune told by a Lama high-priest of Thibet, and it was prophecied then that he would become Emperor of China. Being called by the Chinese loyal party, he went to the Emperor's help, and finding, on his arrival, that the Emperor had fled, and that the throne was vacant, he "sat down," and proclaimed himself Emperor, thereby fulfilling the high-priest's prophecy. This, says the story, was the origin of the present Manchu dynasty, and the success is of course attributed to the old high-priest, who belonged to the Gé-luk-pa sect. Owing to this, the present dynasty nominated that as the official sect, and in order to retain its prayers in favour of the dynasty, the sect is paid a yearly subsidy by the Emperor, and the Manchus believe that were those prayers to cease, the dynasty would fall, and the whole of China be lost to it. The Chinese are fully alive to the probability, indeed certainty, that were Europeans to obtain a footing in Thibet, the influence of the Lamas (already so much hated by the people) would cease, and, as the Lamas themselves express it, "their cup would be broken." With the collapse of the Lamas would vanish the prayers for the dynasty. Thus it is evident how, from politico-religious motives, it is entirely in the interest of the Emperor of China, and of the Lamas, more especially of the Gé-luk-pa sect, to exert every effort to keep Europeans out of Thibet. So runs the story, as believed in Thibet; but there is one drawback, I am told, to its acceptance *in toto*, and that is, that this story about the Manchu general "cannot be reconciled with detailed history." The story, however, is believed in Thibet as I have told it, and the reasoning may be more correct as to its consequences than in the historical details. Then again, the Thibetan petty officials would be obstructive as regards the entry of Europeans, fearing the loss of their unlawful exactions, to which the people would not submit, once they had been taught independence and a sense of justice by Europeans.

The Darjeeling Railway, and the intercourse it permits by allowing Thibetans to visit India, is already making a stir in public opinion in Thibet. It is encouraging comparisons between British rule, with its justice and freedom from official pilfering and tyranny on the one hand, and the unhappy conditions ruling in Thibet on the other, where the people are looted by both Lamas and officials to the last point of endurance.

In concluding my remarks on Thibet, I would narrate four prophecies concerning that country, current there, which are instructive in their way:—

1st.—There is a prophecy to the effect that the Thibetan religion will be replaced by another from the East.

2nd.—That after the 13th Ta-li-lama, there would never be another.

The present Ta-li-lama is the 13th (others say he is the 12th), and even at his selection there was a strong party against raising another, protesting against the inutility and waste of money caused by having one.

3rd.—There is a prophecy among the Buddists, extracted from their scriptures, and much

talked about by the Thibetan people, which assigns dates or terms for the duration of several Buddist sects. According to these dates, the Buddist religion itself should pass away about this time; and it is also said that it will be replaced by a religion coming from the south, not east, as in prophecy No. 1.

It is true that, as regards numbers and wealth, the Lamas were never so well off as now; but it is equally true that, as far as respect from the people and moral strength are concerned, they were never so badly off. Their rapacity, disgraceful misconduct, and immorality, have extinguished all respect for the class as a whole, leaving very few exceptions personally respected.

4th.—This prophecy is to the effect that when a certain lake's water—probably the Tangri Nor or Nam Tso—runs low and becomes salt, then the Lama power will come to an end. This, in the matter of the water, is said to have already occurred.

Now, individually, perhaps, these prophecies might be of little value, but taken collectively, as indicating the presentiment or anticipation of a possible change in the established order of things, they may be taken, perhaps, as the straw to show which way the wind is blowing. Even on the principle of the wish being father to the thought, they are interesting, if not instructive. Further, the effect they would have on the minds and actions of those interested in maintaining the established order of things is perfectly apparent, and may, collectively, be taken as a factor, and added to the reasons I have given why Europeans need not, just at present, waste time knocking at Thibetan doors.

Further, if we consider the tendencies of all English politicians, of whatever party, to object to any extension of British influence, and especially to any territorial aggrandisement, the conclusion is forced upon us that a disruption of the Chinese Empire can only end to the advantage of Russia, and the increase of her resources, in warlike men particularly. It behoves us, therefore, to uphold the Chinese sway, especially in Mongolia and Thibet. Under this particular condition of things, it becomes more evident how important any project must be which shall hold out reasonable hopes of opening Thibet to British commerce in a practical manner, freed from all the objections attendant on any present attempt at direct intercourse, After this digression, I can now return to the question of my proposed overland route towards China, and the country adjacent to our extreme north-east frontier, feeling that any future references to trade with Thibet, which I may have to make, will not be misunderstood.

In the days of the East India Company, this frontier seems to have excited more interest than it has of late, since Afghanistan has apparently monopolised attention. In those days several explorations were undertaken, which remain to this day nearly all we have of authentic information of the country beyond this frontier. I may say that, for the past forty years, we have sat looking at our side of the range of hills dividing us from the neutral ground, this ground which is likely to become some day of such importance, without Government moving a hand or foot to increase our information as to what lies on the other side of that range of hills. Some private planters, like Mr. Sam Peal and Mr. H. L. Jenkins, have made excursions into the intervening hills, and have proved the facility with which they may be crossed. Mr. Jenkins and Mr. Peal are the only living Europeans who have crossed over into the neutral ground from Assam (and Mr. Jenkins I am glad to find here to-night). We have, besides, the results of the old explorations by Bayfield, Griffiths, Hannay, and others, and these show us that there are no physical or political objections worthy of a moment's reflection to prevent our making a good road, or even an extension of the present railway from Makum, all the way to the Irrawaddi.

With such a road, or better, with such a railway, through perfectly friendly country, Europe would be brought into direct steam communication with Chinese traders representing the west of China and Eastern Thibet; and this, with the immense advantage, on which I cannot lay too much stress, viz., that of avoiding altogether the King of Burmah's dominions. By this route, merchandise would never have to cross his frontier.

Once this road were re-opened, or a railway constructed over this short proposed route, of only 150 miles in length, it would be natura to expect the Chinese to avail themselves of it, and come to us at Mahum, Dibrugarh, or, possibly, to Calcutta. Even supposing the highly improbable case of the Chinese not so coming to us, our merchandise would reach them on neutral ground quite independent of China, and would there be handed over to them, and all necessity for treaties with China would be avoided. The Chinese themselves would alone be responsible for passing their

purchases across their own frontier into China.

I have spoken of the neutral ground as "perfectly friendly country." This I feel quite justified in doing, provided we go the proper way to work in winning over its more distant inhabitants to the same friendly attitude we have perceived on the part of those of its inhabitants adjoining our territory, who, for forty years, have been our fast friends and excellent neighbours.

I need not, at this day I feel sure, point out the splendid field for commerce that is now untouched in Western China and Eastern Thibet, and the great importance of tapping that field.

The Yang-tze-Kiang suffices to carry the products of Central and part of Eastern China to the sea, but its upper waters, west of the town called Sui-Fu, not being navigable, Thibet and western Ssu Chu'an are shut out from trade with the east coast and the "treaty ports," and consequently are, at present, practically closed to European trade.

Yunan, the province of China nearest to Burmah, and nearest to Assam, formerly so rich, has, it is true, suffered very severely from the late Mahommedan rebellion; but we have the best authority for believing that it is fast being re-peopled from the immensely rich, and in parts very populous, neighbouring province of Ssu Chu'an. Ssu Chu'an and Yunan are the Chinese provinces most affected by any proposal such as mine.

Some, indeed many, have advocated a route *viâ* the Irrawaddi to Bhamo, and thence to Ta-li-fu. That route, however, so long as Upper Burmah is subject to a king of the stamp of the present one, must be, for practical development of trade, out of the question. Were Upper Burmah under happier rule, or were it annexed to British India, it would allow us to calculate on the Irrawaddi as an alternative route for trade, and one of very great importance, although it would not suffice without my route from Assam, as the peopling of Assam with Chinese labourers being a very important object in my proposals, the Irrawaddi would not serve this purpose; and the Assam route would, for that purpose as well as for permitting through communication between Assam and Upper Burmah, be even more desirable than ever.

The advantages of connecting Upper Assam by railway with Burmah, *viâ* Bhamo, Ava, and Tangu, were the present political objections removed, as regards the Upper Burmah portion of the line, need only to be mentioned to be realised, both from the commercial and administrative points of view.

I am anxious, however, to base the merits of my project on its present advantages, rather than on those of an uncertain though not impossible, nor yet improbable future.

We have seen, then, that trade between Thibet and Western Ssu Chu'an is cut off from Europe by the East, *viâ* the Yang-tze-Kiang, owing to physical difficulties; and that, at present, it is cut off by the South, *viâ* the Irrawaddi, on any large scale, owing to political difficulties.

We have seen that by the Assam route I am advocating, the Chinese traders can be reached within from 40 to 150 miles of our own territory, and on neutral ground, over which no claims nor treaties would crop up to prevent open and unrestricted traffic.

I have coupled with Western Ssu Chu'an, Eastern Thibet, and this is because the system of trade in Thibet is of a peddling, though an exaggerated peddling, character. The Thibetans are "bagmen" on a large scale. Instead of merely carrying samples about, they carry their stock-in-trade. With their stock-in-trade carried on mules, ponies and yaks, they travel vast distances over snow-clad and dangerous passes, and reach in their journeyings well into the provinces of Ssu Chu'an and Yunan.

For reasons I have already enlarged perhaps too much on, the Thibetans are practically prohibited from trading direct with Europeans *viâ* the many passes from Thibet-proper into Assam, and Europeans are not allowed to enter Thibet.

All attempts made by Europeans of late years to enter Thibet from British India have failed. The Thibetans have sufficient influence over the hill savages dwelling between Assam and Thibet, at all events over those immediately adjacent to the Thibetan frontier, to obtain the assistance of these savages in preventing Europeans passing through their wild country before reaching Thibet itself. Hence T. T. Cooper's failure to enter Thibet from Assam, which I have not time to do more than hint at here.

Were this proposed route opened out, however, there would be no objections raised by the Thibetan traders against trading with us on the neutral ground, or in purchasing our goods through Chinese intermediaries. Thus would Eastern Thibet to some extent be opened to our commerce. To give some idea of the

distances overcome by the Thibetan system of trade, it may be worth repeating here that travellers have noticed the Indian rupee so far east as Ta-tsien-lu in Ssu Chu'an; and I have the word of a resident on the Thibeto-Chinese frontier, of twenty-five years' standing, that hundreds of thousands of such rupees find their way from Darjeeling through Thibet to Ta-tsien-lu in Ssu Chu'an. He further told me, as an illustration of Chinese 'cuteness, and of the extensive currency of the rupee at Ta-tsien-lu, that the Chinese money-changers discovered at once, on a new issue of the rupee, a slight difference in the intrinsic value. The Indian fractional coinage is not used, but rupees are cut up into pieces, and used instead as such.

The French are awakening to the possibilities of tapping Yunan from their possessions in Tonkin, and notwithstanding the objections to their route into Yunan (exposed by Mr. Colquhoun), are taking costly measures to develop trade by it, as we have seen of late in the daily papers. This being so, is it not time we should at least keep pace with French energy in a matter of such possible importance? Considering, too, the cost to ourselves would be so very paltry as compared to what the French must spend on their line of country.

The opening up of this proposed route, *viâ* Assam, before it can become of real practical utility, is a matter of years, so much has to be done; although the pecuniary outlay to Government would be very trifling. To begin with, the Singpho language—the language of the inhabitants of the neutral ground—has to be learnt, without a grammar, without a vocabulary even, and learnt through the Assames language, as there are no English or Hindustani-speaking Singphos. Thus anyone unacquainted with Assamesee, attempting exploration in this direction, would have two languages to learn before starting; as, to be dependent upon interpreters in this case, would be a high premium on failure, though my reasons for saying this, based on my acquaintance with the Singphos, would take too long to enter into here.

As regards the neutral ground, I would not pass it by, leaving an impression that it is simply to be considered as so much distance to be overcome before we can reach the Chinese traders, or the site only of a future mart for the exchange of European and Chinese merchandise. On the contrary, it has an importance of its own too. It is a part of a very extensive district, extending up further north than Bathang and Ta-tsien-lu, which is known to be very rich indeed in gold, silver, copper, iron, coal, amber, serpentine, salt, sulphur, and precious stones. The soil is rich and highly culturable on the neutral ground portion. In the Chinese portion of this rich tract, the gold-mining operations are not allowed to be carried on, the Government fearing to attract bad characters in large numbers to any particular points. In fact, I believe the penalty of death is attached to digging for gold. The soil about Ta-tsien-lu, *i.e.*, to the north of the neutral ground, is so rich in gold that men have been known to build houses simply to enable them to dig under them for gold without being discovered. Major Badgley, in a report connected with the Munipur Boundary Commission, to the south-west again of my proposed route, explains how the natives spread skins of animals in the rivers in the evenings, so that the hair catches the gold-dust. In the morning the skins are hung up to dry, and the dust is beaten out. Any large lumps so collected they throw back, giving as their reason that if they kept the fathers and mothers how could they expect little ones in future! This system of gold-dust collecting is said to be remunerative, which is perhaps the most extraordinary thing about it; if it be remunerative, it speaks volumes for a somewhat less primitive system, were civilisation to be allowed a chance.

A friend of mine, who has resided for twenty-five years on the Chinese frontier of Thibet, described to me, at considerable length, the great wealth in metals and minerals of this tract. One tribe, he mentioned, used no other medium of exchange than gold. And it is quite natural, seeing that for centuries there have been no calls made on the mines, as the people between us and China have had practically no use for the gold beneath their feet, and what little they may have used for barter can be indeed but little, considering that large tracts are totally uninhabited, and the balance in parts very sparsely populated indeed. What little gold they may have used has probably been obtained in the crudest way of washing possible, as illustrated by Major Badgley's account just related, and the gold in the matrix has probably never been touched. The same may be said of the unworked silver. The amber, found in the Hokong Valley, and probably elsewhere in this tract, is worked and sent to Burmah and China, where it fetches good value. It is said to be worth up to Rs. 300 per seer, or say £25

per 2 lbs. weight for the local markets. There are said to be magnificent teak forests* in Upper Burmah, and probably these extend well up into the neutral ground. Should it prove to be so, the railway would doubtless find them a source of great profit. Ivory is also brought in small quantities from the neutral ground into British territory, but the overgrown state of the paths, and the old villages having been abandoned on the disuse of the paths since the British occupation of Assam, will not allow of any opinion being formed or based upon present traffic. Traffic of any kind at present is next thing to being impossible, and will continue so till this route is re-opened and villages re-established to supply food to travellers. Rubber is found in the vicinity of the neutral ground, and there is but little doubt it exists in considerable quantity in the neutral ground, as, owing to the present difficulties against bringing it to market, the trees have probably never been tapped.

I think I have said sufficient to show that, apart from all question of trade with China and Thibet, the neutral ground in itself is a by no means uninteresting or unprofitable field for properly conducted exploration.

Were I to enter into particulars concerning its inhabitants, the Singphos, I should require a whole paper for this race, whose origin is still wrapt in mystery, and whose language is unspoken by any European. Suffice it, in brief, to say that they are subdivided into innumerable clans, all speaking the same language. Those nearest to us having, in 1843, felt our power, have remained peaceful and our firm friends ever since, and have given themselves over to agriculture and such trade as their circumstances and surroundings will admit of. They are fetish worshippers, having neither adopted Buddism, which surrounds them on all sides, nor the *quasi*-Hinduism of the Assamese. They are quick and intelligent, and beg for European school-masters to be sent amongst them. They have no written character of their own, but those nearest to Burmah adopt the Shan and Burmese alphabets, according to circumstances, and those near Assam use the Assamese character. Their language is quite distinct from the Shan, Burmese, Assamese, Chinese, Thibetan, Naga, Abor, Mishmi, or any other of the languages of that frontier, so far as the vocabularies I have compiled will allow me to compare them. The race belongs to the Thibeto-Burmah type, and that is as much as we can say with any certainty. Their manners and customs are full of interest, but I cannot enlarge upon them here. They are, possibly, an offshoot of one of the many kingdoms formerly existing in what is now western and south-western Ssu-Chu'an, but which were formerly more or less independent, and nominally under Thibet, instead of being nominally in China as now. The Singphos furthest removed from us, not having felt our power, and at feud with one another, are not the models I would paint their tribesmen on our frontier. But then these latter were no better themselves before they had learnt our power, and they themselves say too, that were the further Singphos once brought within reach of us, so as to realise that once for all they were safe from one another's raids under our shadow, they, too, would appreciate the blessings of peace quite as much, and would be only to happy to turn into as good friends and neighbours as the nearer Singphos. All they require is a master-hand in their vicinity to say, you shall not fight among yourselves, and they would feel security guaranteed, and would give no further trouble. They respect us very much already, and would accept from us what they would resent from either Burmese or Chinese. The security of our rule in Assam (with its justice and freedom) has, in repute, crossed far beyond our frontier line already, and has prepared a real welcome for the extension of its blessings when the time comes. This extension, however, must be offered withtact, and must not be imposed by force. No extension of territory is necessary whatever.

The Singpho country, or neutral ground, may remain independent, and better so for many reasons. The Singphos have great self-respect, and are in many ways gentlemen, and by a proper humouring of their self-respect, they could and should be made into all that could be desired.

Apart from the merchants' side of the question, which renders this the Imperial question it is—if I may be permitted that phrase—it is one of most vital interest to those enterprising Englishmen who have invested millions of pounds sterling in the tea industry of Assam, and who are now beginning to feel so crippled in the matter of labour.

By this route there would be an easy means of supplying Assam with labour sufficient to render it the granary of Bengal, in the latter's

* See "General Report of the Operations of the Survey of India, 1879-80." Appendix to Captain Sandeman's "Report on the Irrawaddi River Exploration," p. 39.

times of only too frequently recurring famine. Assam has soil enough, and a climate bountiful enough, to feed Bengal in its times of scarcity. All it wants to enable it to do so is labour. Yet now, from the want of labour, it has to import its food from Bengal, and is thus an extra consumer, with a most capacious mouth to fill, even when Bengal can barely feed itself.

The climate of Assam, too, is very much better adapted to the Thibeto-Burman races than to the natives of India. In British Burmah the Chinese already settled there have proved how invaluable they would be in Assam. If it were merely as a means of developing that extremely fertile province, and as an insurance against famine in Bengal, the proposal of re-opening this route is one that must bear its merit on its face.

I trust I have now said enough to obtain your favourable opinion as to the advantages of the route, *viâ* Assam, both as entitling it to be considered the only practical one for the purposes of overland trade between India and western Ssu Chu'an and Eastern Thibet; and as a means of insuring Bengal against famine, also of saving the great tea industry now so seriously threatened, and, lastly, as a means of still further developing the most fertile, though most backward, province in the Indian Empire.

The following letter from Mr. H. L. Jenkins, on the subject of the trade route from Assam towards China, will be read with interest, as embodying the views of one of the only two living Europeans who have ever crossed from Assam into the neutral territory:—

November 12, 1882.

My dear Lepper,—By this morning's post I have your letter and pamphlets on a "Trade Route Towards China." The route which you advocate is the one which all who have possessed practical acquaintance with the subject have put forward as the most feasible road from Assam eastwards. Many officers and others, from Capt. Charlton, who first brought this matter to notice in 1835, down to S. Peel, in 1880, have been struck with the importance of opening communication between our province and the Singpho and Shan countries, and, as far as my information goes, the road by the Namroop has been acknowledged by all to present less difficulties than any other line.

My own explorations, which you have referred to in your pamphlet, are, as you know, described in Proceedings of the Asiatic Society of Bengal, for the years 1869 and 1870, and I have nothing of importance to add to those papers. But I must say that it is with great satisfaction that I learn you are labouring to bring this great question again to the front, and I think that the great strides that have been made during the last ten years in developing the material resources of Assam, and the improvement that has taken place as regards communication with Calcutta, abundantly justify you in your proposal. * * * There is nothing dangerous in what you propose, provided the person undertaking the enterprise possesses two qualifications—a knowledge of the Singpho language, and experience in dealing with uncivilised tribes. I think I may say that I have proved this in my own person, for, besides my explorations in this country, I have had occasion, in prosecuting elephant-catching operations, to reside for weeks in Singpho villages, and found myself invariably treated with hospitality and kindness. I crossed the Patkai range at an altitude of about 2,200 feet; but the path taken by the Burmese army, in the invasion of Assam, crossed the ridge at a much lower elevation.

Your first endeavour should be to open this path as speedily as possible, in a rough and inexpensive way, by cutting the jungle. Afterwards, communication could be perfected by degrees. The Singphos are the dominant tribe on this frontier, and their influence extends all the way to Yunan. The word Singpho, or properly Tsimpho, means a man. They are considered men—*par excellence*—by the Naga and Shan tribes. Along the Burmese frontier they are known as Kachyens. Whilst the Singphos are the ruling people, the Khamptis, Phakials, and other Shan tribes are most numerous. They are also the most industrious, cultivating the soil with a diligence most uncommon in those latitudes, and showing considerable alertness in the amber and dâo trade, and such other opportunities of trade as are at present open to them. As soon as the railway is open to Makum, I am of opinion that a trade could be done with these people in the low qualities of piece goods, and in certain kinds of cutlery. I will merely add, that I shall be very happy if I can give you any aid at any time in the good work you have undertaken. It requires very little consideration to see that this is not a mere matter of local importance to benefit only the province of Assam. It is a matter of imperial interest, being nothing less than a direct overland route between India, with 200 millions of people, and China, with 400 millions, a route with which no other European or American nation could possibly interfere.—Believe me, yours very truly,

(Signed) H. L. Jenkins.

DISCUSSION.

Surgeon-Major White said he had resided for some twenty-one years on the frontier, and he considered the route described was the most practicable, and, in fact, the only practicable route for communication with China. He could confirm the extreme accuracy of the paper in all its geographical details

If an attempt were made to approach China, either from Burmah or Assam, a way would have to be forced through hostile tribes; but in the way proposed there would be no such difficulty. The natives of this territory gave liberal assistance to his friend Mr. Jenkins, and also helped Mr. Peel on several occasions. He had known Mr. Lepper for the last ten years, and knew what an aptitude he had for travelling amongst savages and gaining their confidence. He was already known to many of the chiefs, and if this route were to be adopted, he did not think any one else could conduct it as well, or would be as likely to make it successful, as Mr. Lepper.

Mr. TRELAWNEY SAUNDERS said Mr. Lepper appeared to complain that the Indian authorities had not paid so much attention as their predecessors, thirty or forty years ago, to the subject; but if the attention the authorities had paid had not excited so much popular notice as the explorations which took place on our first occupation of Assam, the work had been much more costly and more lasting. A whole series of surveys had been carried out along the line of the hills bordering Assam, as far as the Naga territory, the border separating Assam from this neutral ground. These were not mere reconnaissances, but actual surveys, and, in fact, that border was as well surveyed as any other part of India. He had no doubt the Government would be found fully alive to the importance of this great question, for there was no subject which pressed more on the Government of India than the difficulty of dealing with the highland tribes, who might be said to be under no recognised sovereignty. Fortunately, we had impressed this particular tribe of Singphos with our influence, and they seemed to be in a state well fitting them to receive any assistance we might afford. There could be no doubt of the attractions of that district, judging from the reports of earlier travellers. One part of the country was particularly famous for its amber mines. It was also rich in vegetable products, and probably in gold and other mineral resources. He had little doubt that, if civilisation penetrated it, it would be found an invaluable tract. The Burmese, at present, levied no revenue in that part of the Irrawaddi Basin, although they might claim jurisdiction over this territory, so that practically it was neutral ground. Still, if it came to be occupied, some questions might arise.

The CHAIRMAN said the Burmese exercised no jurisdiction.

Mr. TRELAWNEY SAUNDERS said it had no power to do so. No doubt, in former times, the wealth of the upper Irrawaddi was highly developed. The last explorer who was sent up by British authorities from Rangoon, a native explorer trained for the purpose, said he had seen the remains of very considerable cities, which manifested the wealth and prosperity which must have existed in early days on the roads from China and Burmah to Assam. As to the practicability of the route, one of Mr. Colquhoun's projects was to carry a railway up to Assam from the British Burman frontier, in continuation of the line now making from Rangoon by the way of the Sittang River to Toungnoo. By-and-bye there would be two lines of railway running up towards, if not into, Burmah proper, and it was one of these lines that Mr. Colquhoun proposed to carry through this Singpho territory into Assam, connecting it with the Makum line. He did not know how he proposed to get over the opposition of the Burmese Government. There would be no question about the natural facilities which existed for the formation of such a line. Everyone must agree on the advantages of a line of communication from Calcutta, by way of Assam, into the Valley of the Irrawaddi, down to Rangoon, and so round by sea to Calcutta again. As to the question of the passage of the Patkoi Range, the height above the sea at the lowest point, was declared to be no more than 1,600 ft.; no doubt the passes were rather narrow, but they had afforded facilities for the passage of the Burmese armies which formerly invaded Assam. At the present moment, as Mr. Lepper mentioned, Chinese traders came down into the Valley of the Irrawaddi, and advanced towards the frontier of Assam, as far as Bisa. They did not get any farther, because the paths were overgrown with jungle, which harboured wild beasts, and wherever there was danger from wild beasts, the Chinese traders did not come. The removal of the jungle was simply a question of permanent attention, by the establishment of posts at intervals, where travellers could be lodged, and so on. That was the first step to be taken in opening up this country. It was not a barren country, but simply a country in the hands of uncivilised people who had not the means or knowledge to make the most of it. Mr. Lepper had done wisely in referring indirectly to the Thibetan trade, but he thought he scarcely appreciated its full importance. He (Mr. Trelawney Saunders) could never resist the opportunity, when it offered, of touching on this subject. It was not so long since the introduction of the first sheep into Australia, but that had been followed by the greatest wool trade the world had ever known. In Thibet, however, along 2,000 miles of the Anglo-Indian frontier, was the most ancient and most extensive field in the world for the production of wool—wool of the highest quality, such as was not found elsewhere. In that country also the sheep had become a beast of burden. Besides the wool the sheep had on its back, it could carry a load to the extent of from 30 lbs. to 50 lbs. weight along the most mountainous tracks. Ten or twelve hundred laden sheep could be conducted by half-a-dozen men and their dogs. Having reached some station at the foot of the mountains in the plains of India, connected with water carriage or railways, the flock of sheep when sheared and unloaded, could carry back the manufactured goods received in exchange. He quite agreed with what Mr. Lepper had said with regard to the obstructiveness of the

Thibetans. The Lamas were traders as well as priests, and they forced the sale of tea into that country for their own profit. The consequence was that no worse tea was to be found in the world than in Thibet, although it was close to Assam, and yet they forced every individual to purchase annually a certain quantity of this wretched rubbish. All that was really necessary to develop trade in Thibet was to send native agents across the Himalaya passes to the flock owners of that wool-growing country, and point out to them, having made proper arrangements for doing so, that if they would bring their wool down to certain stations on the navigable waters or railways of the plains of India, they would always find purchasers for their produce to any amount, and at prices which would amply reward their labour. That was a very simple thing to do, but it had not yet been done. All that had been done was to establish a Central Asian trading company; and those gentlemen had gone so far as to carry bales of manufactured goods to Yarkand and Kashgar, including, it was said, silk stockings and other luxuries, expecting to find a market for those sundries. Of course they had been disappointed; they went to a market where people had no money; but they had plenty of raw produce, and the first thing to do was to buy the produce, and then when they had money in their pockets they could become our customers. He did not mention this with any desire to set it up against Mr. Lepper's project, because that project was a most excellent one which would tend to open Yunan and Western China to British enterprise.

Mr. MICHIE (late Chairman of the Chamber of Commerce, at Shanghai) said he could not help feeling a great interest in these subjects, from his experience on the Indian and Chinese frontier. He thought there was vast amount of still undeveloped trade in those regions. The resources were very great, and the people industrious; but they lacked initiative, and that initiative was the province of Europeans, and especially of our own countrymen, to give them. Since the treaty of Tien Tsin, had opened up the Northern Chinese ports, a large development of trade had taken place. There was a large stock of wool-bearing animals in Mongolia, none of the produce of which came into the market to any extent, until foreigners began to penetrate there, and make experiments, often costly to themselves; but now there was a considerable importation of camel's wool. He remembered some years ago, when he was there in very cold weather, seeing some very useful looking skins, with very long hair, which were worn by the Chinese in the form of jackets, and he purchased two for his own use; but he found that these goat-skin rugs were to be seen in every shop in London. There was also a large trade in sheep's wool; he did not know anything about the particular region referred to, but no doubt the same rule would apply to that as to almost every other.

Mr. PFOUNDES asked if Mr. Lepper would kindly give any information with regard to the literature in use amongst the Singphos. It would be interesting to know how far the Chinese classical literature had penetrated into that region. He also suggested that there was a passage in the paper which was calculated to give great offence to his friends the Japanese, and which had no real bearing on the question discussed, namely, where it stated that they had been in the habit of sending ambassadors to China, and had recognised the sovereignty. The Chairman would be very well aware that Japan prided itself on being an unconquered territory, and that expeditions against it from China had always been unsuccessful.

The CHAIRMAN said he did not suppose Mr. Lepper had any idea of casting a slight on the Japanese, as the British Government had also sent ambassadors to China.

Mr. ANDREW CASSELS thought Mr. Lepper would greatly add to the interest of the paper if he would describe a little more in detail the means by which he proposed to gradually make his way from the frontier of India to the frontier of Western China. He (Mr. Cassels) was pretty well aware of what his intentions were, but possibly there were some present who did not know the gentle and cordial way in which he proposed to work.

Mr. LEPPER said he had purposely refrained from giving those details of his plans in his paper; the question being, so to speak, *sub judice* at the India-office, he had not thought it advisable to enter into his personal proposals in a public meeting. However, after Mr. Cassels's invitation, he should be glad to explain his programme. If one depended on interpreters in dealing with savages, you were pretty sure to come to grief, because the interpreter could make you do just what he liked. If, after going a certain distance, he got tired and wished to return, he had only to say that the people further on were not friendly, that he saw cross arrows, and so on, which indicated that you were sure to be murdered if you went any further, and could thus impose on you to any extent; although the people beyond might be perfectly friendly, still you turned back simply from an imaginative danger. Now, having had some experience in this district, the plan he proposed was to take up his residence at Makum, where there were a great many Singphos settlers, for a couple of years—not definitely on the spot, but thereabouts—giving time and opportunity to learn the language spoken by these people, which was universal all over that tract right away to the frontier of China. If he felt he could safely venture in the cold weather to go a little further, he should take advantage of the opportunity, and get known to the people beyond. These Singphos had somewhat peculiar prejudices and customs; if you went amongst them as an invited guest, they would be responsible for your safety and comfort, but if you went uninvited, they looked upon you with suspicion; therefore, to gain their good-will and invitations would be one of his first efforts.

Each cold season he should try and go a little further, and become acquainted with those living a little further ahead, who would be probably coming backwards and forwards. He should take with him toys of various kinds, and endeavour to instruct and amuse them in such a way as to gain their sympathy and obtain their invitations. After reaching the Irrawaddi Valley, he should persuade a few to come back with him to Makum, show them our railways and steamers, and if he could get the consent of the Government, take a few even down to Calcutta, and then, of course, take them back to the point of departure. This would be of immense service, because rumour travelled to an incredible extent all over these countries. For instance, the rumour of the Darjeeling Railway penetrated right through to Batang within a few months, as he was personally informed. The story the Chinese would tell on their return, would soon penetrate into Eastern S chu'an, and trade would soon follow. He should feel perfectly secure in the neutral ground, and should never carry a weapon, because he would never go beyond a point without being sure he had left everything perfectly secure behind. When he had gained the confidence of the Chinese, it would be time to consider what terms could be made with the Singphos to construct roads; they would only want the jungle cut, and the roads made to allow the Chinese traders to come. The railway company, which was already started up there, would then consider whether it was advisable to continue it to the Irrawaddi, and possibly to join with the one proposed by Mr. Colquhoun to be made through Upper Burmah.

Mr. E. KIMBER asked if Mr. Lepper could tell them about the number of inhabitants per square mile in this territory.

Mr. LEPPER said the most recent explorations of the country dated forty-eight years back, and sincethen great changes had taken place. The Burmese were former rulers of Assam, and the road from Assam into Burmah was by this very route he proposed. In those days they had posts at about fifteen miles distant all along, and the road was kept well opened. He must be distinctly understood to be adcocating the re-opening of an old, and therefore practicable, route.

Mr. KIMBER said at present he was not contemplating a railway, but he considered that when they had sufficient influence to induce the people to make a road, the natural resources were capable of such development as would soon make a railway pay, even without counting on the Chinese trade which would accrue.

The CHAIRMAN said this subject was one of intense interest, and of material importance. In the largest view we had in Assam, formerly in the possession of Burmah, a country of magnificent resources which were only partially developed at this moment. As regards tea, the progress made was marvellous. He remembered, not long ago, Assam tea was only heard of as supplying a certain market in India, and coming rather as a rarity into England; but now he believed upwards of twenty million pounds came into this country.

Surgeon-Major WHITE said fifty-four millions.

The CHAIRMAN said this article was enormously developed, and it was a very fine tea; it was not at all impossible that, at no distant date, Assam might produce a tea as fine as any China could supply. It would not be at all a bad thing to have two strings to our bow with reference to our tea, and at all events, competition was good for the consumer. Capital was not wanted, for there was plenty, but only labour. It might have struck many people that it was very strange in the immediate vicinity of the Valley of the Ganges, and Bengal, which was an over-populated country, that there should be any difficulty in getting the necessary labour in Assam; but he was credibly informed that the Bengalese, who were not a very hardy race, could not bear the climate of Assam, although it was a fine climate in many respects. Therefore, the necessity of a large amount of labour pointed to Burmah and China as the countries where labour could at once be produced, which would be cheap, easily available, and with great powers of endurance. It became a vital question, with reference to the development of Assam, whether you could get that labour. It would certainly not pay to import the Chinese to Calcutta, and then send them up the Ganges; the expense would be too burdensome to the tea-producer to make such a proceeding profitable. But if they could make an overland road, in a neutral territory, between Assam and China, the end would be attained. It simply required 20 ft. to be cut through the jungle in a country which offered no physical obstacles, because the mountains ran north and south, and in the valley of the rivers that led to the Irrawaddi, and along the Irawaddi itself, there would be no difficulty. He would remind the meeting that the greatest civilisers in the world, and the greatest rulers, the Romans, were also the greatest road makers. The first thing to be done to utilise a new country was to make roads. It was not a question of a railroad, which was a more or less costly operation, and which could never pay unless you had sufficient population, or an immediate prospect of attracting new population and trade. If this road were once made, not much more than 150 miles in length, which might be easily accomplished, with a certain amount of Government influence and assistance, such was the trading instinct of the Chinese, and such their enterprise, that it would only require they should see a road towards the entrance of our Indian Empire, where the railroad commenced, and where there was always a large traffic going on, for the Chinese to swarm up it as they did up any road where there was access to profitable markets. Of all the routes proposed during the last twenty or thirty years to connect our Indian Empire

with the western territories of China, none had been so full of promise, or seemed to present so little difficulty. The greatest obstacles had never been physical but political; and as Thibet and Burmah were, more or less, under the influence of China, and both those powers were of a hostile and exclusive character, they made with China a sort of tripartite alliance, so that no dependence must be placed upon their assistance or even their neutrality. but these Shan tribes were practically independent, whatever pretensions of Suzerain authority there might be. Wherever an empire laid claim to territory it was very slow to retire; still, if they had ceased to exercise any jurisdiction, the opposition they could offer would be very trifling. Assam was looked upon as merely a tea-producing country, but it had an admirable soil, and only labour was required to make it a great rice-producing country. At present it drew rice from Bengal, which, in times of famine, could not be spared. But if they had a large quantity of rice grown there, with a Chinese population, there would be an admirable resource for the Gangetic region in a time of scarcity, and that of itself was a matter of great national importance. In every way, therefore, it was a matter of great interest to determine whether it was not practicable to drive a road through this neutral territory, where there were apparently settled and friendly tribes; not over the Chinese boundary, but in such close vicinity that, he would answer for it, the Chinese, without waiting for the consent of their Government, would soon find their way across. This was so important in an imperial sense, that every possible means should be taken to induce the Government to give it the most favourable consideration, and to see what amount of assistance they could give. As far as he understood, the proposal of Mr. Lepper was of the most moderate kind. He thought it would take him two or three years to make himself master of the language, and a thousand rupees a month, with the loan of two or three elephants in the cold season, would really be all the assistance he immediately required. He was quite sure, if the Government would adopt the view he was now taking of it, that assistance would not be refused. All who took any interest in our commerce must see the vast importance of pursuing this project, and of seeing whether we had not at last discovered a route which was practicable with very little aid, and without danger of political complications. He would be very glad if the reading of this paper helped to ventilate the subject and bring it under public notice. He concluded by proposing a hearty vote of thanks to Mr. Lepper, which was carried unanimously.

TWELFTH ORDINARY MEETING.

Wednesday, Feb. 21, 1883; Sir FREDERICK BRAMWELL, F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Bond, Miss Ellen Elizabeth, The Elms, Twickenham-park.
Cazalet, Edward, 4, Whitehall-gardens, S.W.
Field, Leopold, Lower Marsh, Lambeth, S.E.
Massey, William Henry, Twyford, Berks.
Pidgeon, Daniel, Holmwood, Putney-hill, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Brockbank, William, Brockhurst, Didsbury, near Manchester.
Huth, Alfred Henry, 17, Kensington-square, W.
Joachim, Henry, 25, Phillimore-gardens, Kensington, W.
Mathew, Francis, 103, St. George's-square, S.W.
Moenich, Oscar, 8, Coleman-street, E.C.
Richards, Edwin, Caldicot, near Chepstow, Monmouthshire.
Ricketts, Miss Florence, 1, Gipsy-hill, S.E.
Thorn, Alexander, 1, Elm-park-gardens, S.W.

The paper read was—

RECENT IMPROVEMENTS IN AGRICULTURAL MACHINERY.

By DANIEL PIDGEON, Assoc.Inst.C.E.

Twenty-five years ago, Mr. Sidney read a paper before this Society, which ably summarised twenty years of progress in the manufacture of agricultural implements, a subject which, so far as the transactions of the Society of Arts are concerned, has slept since that time. In dealing with the changes which took place in the practice of agricultural engineering between 1837 and 1857, Mr. Sidney was, so to speak, in the position of the historian who records the period of a people's passage from barbarism to civilisation, and his contrasts are correspondingly startling and interesting.

A writer on recent improvements in agricultural implements has no such advantage. His story is necessarily more or less commonplace; for although, as in the case of harvesting and milling operations, some changes of a revolutionary character have taken place, agricultural implements have been little altered during the last few years, and the period since Mr. Sidney wrote is characterised less by the introduction of novelties than by improvements in manufacturing processes. Within the walls of the factory, indeed, a silent revolution has been accomplished. The

"Implement Maker" has become the "Agricultural Engineer," properly so called. His materials are skilfully chosen less with reference to first cost than to the work to be done. He employs the best plant that skill can devise or money buy. He introduces special tools, and reduplicates, as far as possible, all the parts from which a machine is built. His shops are no longer sheds, but the foundry is full of moulding machinery, the smithy of stamps, and the machine-shop of milling tools. He subdivides labour, systematises all work-shop operations, and has taken science into partnership in every department of his business.

Lord Vernon in remarking, at the last Royal Agricultural Show, on the growth of the implement department, says that whereas only 312 implements were shown at Liverpool in 1841, the first year in which statistics were collected by the society, no less than 3,947 appeared at Canterbury in 1860, and 6,102 at Reading in 1882. These figures sufficiently indicate how wide is the field over which a glance has to be taken this evening, and how general that glance must necessarily be; but they are not the only testimony to the rapid growth and importance of agricultural implement-making as a national industry.

It is, indeed, a formidable matter merely to classify the farm machinery of the present day, which may, however, be conveniently divided as follows:—

Class I.—Prime Movers.
,, II.—Drainage Machinery.
,, III.—Appliances for the Reclamation of Land.
,, IV.—Tillage Implements.
,, V.—Sowing Machines.
,, VI.—Harvesting Machinery.
,, VII.—Machinery for Preserving Crops.
,, VIII.—Barn Machinery.
,, IX.—Food-preparing Machines.
,, X.—Hay and Straw Compressors.
,, XI.—Milling Machinery.
,, XII.—Dairy Appliances.
,, XIII.—Poultry Farm Appliances.

To these headings an equal number might be added by including machinery in use for a number of operations, only a little less strictly agricultural in character, such as the making of farm roads and railroads, the manufacture of manures and cattle foods, the irrigation of land, the processes of hop-drying and malting, the retting, breaking, and scutching of flax, mechanical forestry, sheep shearing, and homestead tools.

Class I.—Prime Movers.

The first compound engine ever seen at a Royal Agricultural Society's show was exhibited at Liverpool in 1841 by Ransomes and May. Forty years later 240 engines of all kinds appeared at Derby, and the production of agricultural engines is now numbered by thousands annually.

The first portable engine ever seen at a Royal show was shown by Messrs. John Fowler and Co., at Kilburn, in 1879. It was, however, only semi-portable; and it was reserved for Messrs. Garrett and Sons to bring out the first portable compound engine, at Carlisle, in 1880, a lead which has been quickly followed by several eminent makers.

An unofficial trial of Garrett's engine was made in November, 1880, by Mr. Pendred, of the *Engineer* newspaper, and the published results, which are very favourable to the system, are highly interesting in themselves. It appears that the engine in question did a higher duty than has ever been recorded at a Royal Society's meeting. Even the famous performances of the Reading Iron Works, and Clayton and Shuttleworth engines, at Cardiff, in 1872—till then, the best on record—were apparently badly beaten.

It is well known that the highly economical, or "racing" engines, to which so many honours have been adjudged by the Royal Agricultural Society, are not those which manufacturers recommend to farmers. They are, indeed, too delicate for the men who drive them, and single valve engines, with a low rate of expansion, are accordingly sold instead, because experience has proved that these in the long run do best, and fare best, in the hands of half-educated mechanics. If the introduction of the compound engine, already so successful in the factory, the mine, and the steamship, should enable the farmer to realise an economy of which he at present only reads in the *Journal of the Royal Agricultural Society*, it is sure of a welcome.

Feed-water heating has received, as it deserves, considerable attention from the makers of portable engines. Messrs. Brown and May, of Devizes, were among the earliest to make an apparatus of this kind to form an integral part of the engine. Their plan was to carry the exhaust-pipe from one end of the boiler to the other, surrounding it with a narrow annular space, through which the feed-water

passed on its way to the boiler. It was, however, soon found that the men who take charge of agricultural engines were unequal to the management even of this simple apparatus, which was so often left full of water in frosty weather, that the plan had to be abandoned for another and less efficacious one.

A very pretty application of the well-known principle of Giffard's Injector has been made use of for water heating by Messrs. Garrett and Sons. The pump discharges either directly into the boiler, or through a nozzle into the water tank. This nozzle is surrounded by an annular space, to which the exhaust can be admitted at pleasure. When the boiler is not being supplied, the feed-water is forced back into the tank through the nozzle, in the space around which a partial vacuum is created by aspiration. Into this vacuum the exhaust steam rushes, is condensed, and issues with the feed-water, to which it gives up its heat. In regular work, the feed valve may be set so as to provide the boiler with a constant supply of water, and to return the residue through the water-heater, raising the feed-water to a very high temperature without producing any back pressure on the piston. A few steps farther might have carried the inventor of this elegant device to that remarkable extension of Giffard's fruitful idea now known as the "Exhaust Injector."

It is quite impossible to enumerate all the improvements that have been made during the last few years, in self-moving engines, but attention must be drawn to three points of modern practice, on which the present reliability of these great machines largely depends. It was once the universal custom to mount the working parts of self-moving engines on brackets bolted to the boiler, and the strains thrown on the latter, through the moving parts, were so severe, that their effects were soon observable in leakage and corrosion at the bolt holes. In 1870, however, Messrs. Aveling and Porter prolonged the side plates of the fire-box itself upwards, forming these into brackets for carrying the bearings of the crank and counter shafts, and relieving the boiler itself from all undue local strains.

Previously to 1878, again, the gearing of self-moving engines had always been placed outside the crank brackets, but in that year, for the first time, Messrs. Aveling and Porter succeeded in bringing all the wheels and pinions between the bearings and the driving and fly-wheels close up to the side-plate brackets. By this arrangement, the engine became immensely strengthened, its wear and tear correspondingly reduced, its width lessened, and its compactness increased. If to these two important improvements be added the use of steel, instead of iron, in all the axles and gearing, the chief advances in these engines may be said to have been summarised.

The straw-burning engine, a novelty ten years ago, is now commonly made by most engine builders. The use of steam power has extended very largely of late, in various parts of the world where, though grain is largely grown, coal and wood are dear and scarce. On the treeless Steppes of Hungary and South Russia, dried cattle dung was the only substance that could be burnt in steam boilers until straw was used as fuel; and in the wheat-growing districts of Italy, where the grain needs to be thrashed soon after harvest, the farmer is only too glad to make use of steam-power for this purpose, now that he can burn straw. South America, New Zealand, and Mexico again, to say nothing of California, which is supplied with straw-burners from the States, are all countries requiring steam machinery which consumes no coal.

It was under these circumstances that Messrs. Head and Schemioth commenced experimenting on the combustion of straw in boilers, in the year 1873. Others were on the same track, and the thing, indeed, was already done in a rough way in Russia and Hungary; so that if Messrs. Head and Schemioth's plans are chosen for notice, it is because they resulted in an engine now commonly regarded as the type of all straw-burning schemes.

Their apparatus consists of a pair of toothed rollers and feeding-box, placed in front of the furnace door of an ordinary portable engine. These rollers are set in motion by a strap from the crank shaft of the engine, and thus, by means of a continuous mechanical feed, straw is forced into the furnace in a thin stream and in the form of a fan. The fresh fuel is practically held in suspension for a short time, allowing the separate stalks to become immersed in the flames, while the long pieces of the straw have the effect of stirring up the half-burnt material in the furnace, keeping the whole in motion, and permitting a sufficient ingress of atmospheric air for the combustion of vegetable matter.

It was thus found that the calorific value of dry straw is as 1 to $3\frac{1}{2}$, compared with coal; or, taking the relative local values of coal and

straw into consideration, the use of the former costs $3\frac{1}{2}$ times more than the latter in such countries as Russia and Hungary. In England, on the other hand, coal is the cheaper fuel by 5 to 1, not only because of its lower price, but because straw itself is a valuable article of commerce here, while it is practically useless in the countries to which attention has been drawn above.

The consumption of fuel in straw-burning engines is from 15 to 18 lbs. of straw per horse power per hour, a quantity which can be easily burnt without any serious addition to the size of the fire-box or area of heating surface common in portable engines. Hence the straw-burner is spreading widely all over the world. Commencing its useful existence on the wheat fields of South-Eastern Europe, it has found its way eastward to India and Egypt, and westward to the plains of the Sacramento and San Joaquin. It indeed becomes a question whether the land of some countries may not yet be ploughed, their crops harvested and thrashed, and the grain ground into flour, by steam-engines fed with the vegetable refuse grown on the spot.

Class II.—Drainage.

"Nothing in the way of aid to suffering agriculture at this juncture can be conceived of as more valuable than a really efficient drainage tool." So spoke the reporting Judge of the Derby show in 1881; but the Royal Agricultural Society's Gold Medal, annually offered for such a machine, is still unawarded. A promising aspirant for this prize appeared at the Derby show, but failed to make good its pretensions. This implement, the invention of Messrs. Robson and Hardman, looks like a dredger ashore, excavating by an endless chain of buckets, of which there are two series, one following and cutting deeper than the other. The body of the machine contains the drain pipes, which descend, through a curved "pipe conductor," into the trench formed by the buckets, where they are left lying in sequence as the machine advances. The dug soil is elevated, just as in a dredger, and discharged into shoots, whence it falls again into the trench from which it was originally removed, covering the drain pipes that have meanwhile been laid therein.

An effort was made to show the working of the machine at Derby, but the dredging scoops, being set at a wrong angle, anchored themselves, and the thing failed. An improved form of the implement was promised for the following year, but did not make its appearance at the Reading show. Several practical difficulties attend the problem of automatic pipe-laying. It is not easy to provide for a proper and equable fall. It is difficult to place the pipes accurately in contact end to end, and it is a question how turning at the headlands is to be accomplished. But the English and American Patent Offices afford evidence that draining machinery is now engaging the close attention of inventors, and Mr. Coleman's aspiration for a good tool of this class may yet be realised.

Fen drainage is a matter to which allusion is made here, in order to bring under notice a new turbine pump, by Messrs. Holmes, of Norwich. This was shown for the first time last year at Reading; but already it is rising into favour in the Fen district. In place of a rotary pump of the ordinary type, with suction and delivery pipes, Messrs. Holmes sink a turbine wheel, cased in a iron cylinder, into the marsh dyke, and drive it either by a windmill or portable engine. The outlet from the iron casing is a door which swings open on its hinges whenever the column of water raised by the turbine is higher than that in the discharging channel, and closes when it is lower. With a windmill as motor, the action is perfectly automatic. While the sails turn, the turbine revolves, and the discharging door is open. When they stop, the door closes, and the simple apparatus awaits more wind.

Class III.—Reclamation of Land.

England is so often compared to a garden, that Englishmen scarcely realise how many millions of acres of waste land still exist in these islands. More than one-fifth of all Ireland is uncultivated, Connaught alone, its smallest province, containing a million and a-half unreclaimed acres. In some parts of Scotland matters are worse. Sutherlandshire, for example, is hardly scratched by the plough, not a fortieth part of its area being yet under cultivation, notwithstanding the grand efforts at reclamation which have been made by the Duke of Sutherland, in conjunction, it must be added, with Messrs. John Fowler and Co., of Leeds.

The Duke's first schemes were carried out on a small scale, by hand draining and trenching, but an attempt was early made to do the work by steam power. A common plough and a portable engine were tried about 1870 at Uppat, where the land was deep bog, and

here his Grace spent many hours watching the steam-driven plough battling with boulders and tree roots. The more mishaps befell this crude apparatus, the more determined the Duke became to carry out the work by means of steam power, and, in 1871, a special plough and a pair of 14-horse power engines were procured from Messrs. John Fowler and Co., for the purpose. By this set of tackle, and after immense difficulties, the surface was at length ploughed, and a new era in the work of land reclamation commenced. As the Duke's operations extended year by year, so the "Sutherland Plough" was gradually improved, until it became a strange looking implement indeed, but a perfectly efficient tool for the performance of work which no engineer would have considered within the compass of machinery ten or a dozen years before.

The plough is furnished with a single huge turn-furrow, and to prevent the implement burying itself in the boggy land, it is carried on four wheels, broad enough to be called rollers. Two of these form the land wheels, and are cylindrical in shape, while the two furrow wheels are great cones. The conical form is necessary for pressing the newly-turned furrow slice into its place, or otherwise the tough sward would roll back into the furrows. The coulter consists of a steel disc, placed vertically in front of, and cutting the soil below, the sock. When this disc meets with a landfast stone or stump, which it can neither stir or split, it revolves over it, and lifts the plough clear of the obstruction. Behind the plough proper, and pivotted to its framework, hangs the "Duke's toothpick," a huge iron hook like the fluke of an anchor, which is brought into work by the action of the tail rope, and stirs the subsoil to a depth of from eight to eighteen inches. Such obstructions as the coulter rolls over, the "toothpick" attacks, the gear being strong enough to pull the engines up, before anything gives way; and where his Grace's persuader fails, dynamite is the only resource.

Mr. Greig's "Discer" and Randall's "Pulverising Harrow," the latter an American tool, must not be omitted from mention in this connection. The former was first used in Sutherlandshire in 1876, while the latter has done good service on Mr. Mitchell Henry's Kylemore reclamations. In both these implements two axles, set askew to each other and to the line of draught, carry a number of thin discs, which, revolving as the machine is drawn forward, cut the peat to a few inches in depth, and being at an angle with the line of advance, throw the surface mould into little furrows, at the same time disintegrating the turf.

Class IV.—Tillage Implements.

The plough is older than human history, for it is found figured on some of Egypt's earliest monuments, yet thousands of years have not exhausted the possibility of its improvement. It is, indeed, only fourteen years ago that the introduction of the Pirie plough seemed about to produce a quasi-revolution in the practice of ploughing. Double-furrow ploughs are, it is true, no novelty. They were described 200 years ago by a writer in Cromwell's time. Arthur Young gave a drawing of one in his "Tour to the North," published in 1771, and Lord Somerville took out a patent for such a plough in 1802. A Leicestershire ploughwright, named Handford, soon followed with a double-furrow plough having adjustable beams for changing the width of the furrows, and these implements were generally popular in the early part of the present century.

But they all ultimately died, and the subject slept until Pirie's plough appeared in 1868. This well-known implement consists of two plough-bodies carried on a framework of wrought iron, supported on three wheels, of which two, having V-shaped tires, run in the furrows, and one on the land. The leading furrow-wheel is steered by a lever, and plough-handles are dispensed with. The pith of Pirie's invention consists in mounting the furrow-wheels on inclined axes in such a way as to bring their tread into the angle of the furrow usually occupied by the slade. The last is dispensed with, and the plough, therefore, rolls instead of sliding forward, the draught being correspondingly diminished, and two furrows traced almost as easily as one by the common plough. A feverish interest was for a time excited by this invention; a host of imitators followed Pirie's lead, and some sharp engagements took place over disputed patent rights. But the objection to Pirie's plough was its want of proper means for raising and turning in at the headlands. The double-furrow ploughs, to which allusion has already been made as popular in the beginning of this century, fell into disuse from the same cause, and the most important result of Pirie's invention was to cause improvements in this respect in the old class of multiple furrow ploughs.

A medal of the Royal Agricultural Society of England was awarded to Messrs. Ransome, in 1870, for a means of lifting double ploughs, and by this device, which was twice improved, in 1871 and 1873, multiple ploughs, with any number of beams, can now be raised and turned in at lands end. The plough is provided, about the centre of its length, with a through axle, cranked at each end and carrying a pair of travelling wheels. When the implement is in work, the cranked axle is in such a position that its wheels are off the ground, but on the ploughman releasing the catch which holds it thus, the wheels take the ground, and the onward movement of the horses rolls them under the plough, raising it at the same time, until the cranks are vertical, when they come against a stop, and the implement rides about like a cart. Messrs. Howard accomplish the same end by means of a break, which the ploughman can apply to one of the plough wheels at will, utilising the energy thus obtained from the horses through suitable levers for lifting the plough-body.

Many years ago Dr. Jones, the editor of *Franklin Institute's Journal*, wrote as follows:—"Our farmers are coming out in the world; they light their cigars, mount their ploughs, and go to work like gentlemen." The reference is to the general introduction, now more than forty years ago, of the "gang" or pole-plough in America, an implement which makes very slow progress in public favour here. Messrs. Howard, of Bedford, and Messrs. Cook, of Lincoln, showed such ploughs at Derby in 1881, but, though these implements are light in draught and capable of doing more work than ordinary ploughs, the prejudices of the British farmer are altogether against a ploughman riding. Similar objections were once made to seats in other classes of field implements, but they are now giving way, and it is to be hoped that this may yet be the case in regard to "gang" ploughs. The agricultural labourer, though hardly yet an expensive luxury, is scarcer and dearer than he was, and long before the British farmer approaches the condition of his fellows in Ohio, or Illinois, where there is one labourer to every four farmers, gang ploughs will be the order of the day in England as well as in the States.

It is a question whether the turnwrest plough, which has been in use from time immemorial in Kent and part of Sussex, was the primitive plough of Oriental countries. The "rist" or breast, as the name implies, can be turned from one side of the plough to the other; and the ploughman, commencing his work on one side of the field, continues turning the furrows all in one direction, until the whole is finished. He thus makes no open furrows, to which there are many objections, but leaves the land with an even surface, just as the spade does. Turnwrest ploughs are made on four different plans. First—The mould board turns over from left to right, and *vice versâ*, as in the American hill-side plough. Second—One or more plough bodies revolve on a horizontal axis, forming the beam, one set standing vertically, while the other is at work. Third—Two or more right and left-hand ploughs are balanced, as in the steam-plough, and used in the same manner. The fourth and last plan, which was patented by Mr. Muriston in 1876, is the only one that calls for special notice. Mr. Muriston places two ordinary plough bodies, a right-hand and a left-hand one, back to back, with the ends of their turn-furrows almost in contact. These he attaches firmly to a small wrought iron frame, supported on a central wheel, which, as in Pirie's implement, acts the part of slade, and upon which the two bodies balance. The beam and handles are like those of an ordinary plough, and are pivotted to a vertical stud, rising from the centre of the plough frame already described. They can thus be swung round horizontally, while the plough bodies themselves remain stationary and looking in opposite directions. Catches, under the control of the ploughman, are provided to fix the beam and handles in the proper position for ploughing in either direction, and when the implement has arrived at the end of a furrow, the horses, in the act of turning, bring these into line for the return journey. Lowcock's plough, introduced by Ransomes in 1844, had several features in common with Muriston's later inventions.

The limits of time forbid any attempt to dwell on the gigantic subject of steam tillage, which may be touched all the more lightly because its true principles were ascertained a good many years ago. With regard to the motive power, it is now acknowledged that this should be applied as directly as possible to the work, and it has been found more economical to use two engines, notwithstanding their greater first cost, rather than change the direction of the hauling rope. Fisken's clever plan of transmitting the power by means of a light rope running at a high velocity is, how-

ever, still successfully used in hilly places where the double-engine system is inapplicable.

As to the cultivating implements, it may be said generally that since the Fisken and Fowler patents of 1855 and 1856 expired, plough makers have adopted the see-saw movement of the latter in preference to the balance of the former patentee. Two patents, Wood and Whewell's (1876), and Catley's (1877), which aim at shortening the length of the balance plough, have been reduced to practice, but both plans need almost as wide a headland as the see-saw implement, and in every other respect are inferior to it. The old Fowler plough, improved in detail since its introduction — notably by a patent of Mr. Greig's, dated 1877—still remains the same in principle as that which was first exhibited at Chelmsford in 1856, and has become the type of all succeeding balance ploughs of value.

Mr. Smith, the father of the "smashing" system, handed over his patent for a turning cultivator to the public some time before its expiry in 1870. But Messrs. John Fowler and Co. had already solved this problem in a different way, the framing and tines being raised and the implement turned round at the headland by the pull of the tail rope on its coming into action as the hauling rope. Messrs. Barford and Perkins, in 1880, introduced another ingenious plan of raising a cultivator by means of cams and ratchets; but while turning cultivators generally are well adapted to the "smashing" of land, the balanced implement still retains its proud superiority, whether for deep subsoiling, digging, or knifing.

The self-moving anchors of Fowler, Howard, and Barford are all mechanical contrivances of great merit, and factors of the utmost importance in the success of steam ploughing with a single engine. In one system, as is well known, the plough travels backwards and forwards between the engine and the anchor, the latter consisting of a frame carrying a horizontal sheave for the rope, and resting on thin discs, which cut into the ground and resist the side strain of the engine. The anchor is drawn along the headland after every bout by the direct pull of the hauling rope, and when it has moved the proper distance is itself anchored by tines. These are lifted out of the ground every time the plough comes up to the anchor, which then becomes free to move along the headland with the work. All this takes place automatically. No men are needed on the anchor, the ploughman being able to control the distance it moves after each bout without leaving his seat. In another system, called the "round-about," the engine is stationary, and there are two movable anchors, one on each headland. Many attempts have been made to supersede the plough altogether by mechanical digging, and Darby's steam-digger must not be passed by without notice, although the plough still holds its ground against all competitors.

It is now rather more than a quarter of a century since the late Mr. John Fowler, speaking before this Society, anticipated that the general adoption of steam cultivation would save this country half its yearly account for agricultural horse labour, which he placed at fifty millions sterling. That, perhaps, was too bold a prophecy, and the British farmer of to-day would accept only too thankfully any share, however modest, of the annual twenty-five millions which agriculture was to gain from steam tillage. But if financially too sanguine, Mr. Fowler was mechanically correct in his anticipations, and himself lived to see what he then called an idea, "conceived in the minds of those who are more poets than mechanics," an assured practical success.

Class V.—Sowing Machinery.

Drill-culture has become so universal in England, that it will be unnecessary to treat of the subject now under review in its two-fold aspect of broadcast sowing and drilling in rows, but only to discuss some of the more interesting features of the latter system. Water drilling and manure distribution again have remained for so many years without important changes in the well known principles embodied in the Chandler and Chambers drills respectively, that these also may be disregarded in an account of recent improvements in sowing machines.

A good drill should sow uniformly the same quantity of seed, whether travelling on level ground, along the side of a hill, or up and down hill. It should adapt itself, not only to all kinds of seeds, but to all conditions of such seeds. The regulation of the quantity to be sown per acre, the shape of the coulters, and the steerage of the machine, are all matters of importance, but even sowing is the most important of all.

The last trials of corn and seed drills, conducted by the R.A.S.E., took place at Bedford, in 1874, and clearly evidenced that this class

of machines is still capable of considerable improvement. Equal distribution of seed to each furrow was the point on which the judges principally insisted, and great was the surprise of some exhibitors when they saw canvas bags hung on the seed tins of their machines, and their contents weighed after a run of 200 yards. This simple test, however, disclosed some remarkable irregularities. The difference between the quantity of oats received by two furrows was, in one case, at the rate of 40 lbs., or a bushel, an acre, while even the first prize machine varied as much as 7 lbs. an acre.

Almost all the drills exhibited at Bedford were fitted with the well-known cup delivery, which is now universal throughout England and the Continent. Theoretically speaking, cups should be perfectly regular in their delivery on level land; for if they are alike in capacity, and are all set at the same angle to the diameter of the cup-wheel, they cannot fail to discharge exactly the same amount of seed with every revolution of the wheel-spindle. Practically, however, it is a difficult matter in this class of work for the maker to set every cup rightly, and every hopper almost in contact with the cup-wheel, while the stems of seed-cups are easily bent, and the tin hoppers easily misplaced in working.

Mr. Smythe, of Peasenhall, who has always occupied a leading place as a drill maker, and who, it must be remarked, did not compete at Bedford, seems unusually alive to the importance of perfecting the cup-delivery drill in the two particulars now under review. His cups are accurately set on a system of his own, and, in 1878, he patented a very ingenious drill-hopper, which can be turned aside to allow of the easy removal of the cup-wheel spindle, and then turned back into position so exactly that the most careless labourer could not fail to bring it close up to the cup-wheel. Regular seeding on rough or hilly land will always be difficult with cup-drills; first, because of the way in which the machine is shaken by stones or clods; and second, because of the obliquity of the cups on hill-sides.

Messrs. Coultas, of Grantham, showed a drill in 1881, at Derby, fitted with a "force-feed" similar to that of the McSherry drill, which is in common use in America. The McSherry feed is simplicity itself. The bottom of a hopper, containing seed, is closed by a spirally grooved roller which, revolving as the machine advances, supplies the seed in a regular stream to the coulter. The speed of the roller is constant, so that change wheels are avoided, and the amount of seed sown is regulated by sliding the feed roll laterally, thus exposing more or less length of the feeding grooves. A "follower," or blank portion of the roll, closes the aperture in the hopper, which this movement would otherwise occasion.

So far as regularity of delivery is concerned, the McSherry feed is perfect. Its discharge does not vary more than 10 ounces per acre, and a drill of this kind, which was tested before the British Commissioner at the Philadelphia Exhibition, did not vary more than two ounces per acre, while its performance was quite unaffected when working at an angle of thirty degrees. English makers say that the "force-feed" is liable to grind the seed, that it cannot be used, as the cups can, for every kind of seed, and in particular that it will not sow very small seeds; but, in view of its immense success in the States, and the demand for greater regularity of delivery, it is probable that more may yet be heard in England of "force-feed" drills.

The silver medal of the Royal Agricultural Society of England was awarded to Messrs. Murray, of Banff, in 1880, for a new and clever potato planter, which requires a moment's notice. This machine consists of two large iron hoppers containing the eyes or "sets," and mounted on two travelling wheels, from whose axis an endless chain, formed of a series of cups, passes up through each hopper, each cup taking up a "set" as it passes through. The sets are tipped over into a spout as the chain turns over its upper pulley, and are carried down with the chain to the bottom of the spout, whence they are discharged into the furrow. The original machine was the invention of Mr. Ferguson, of Kinnochtry, who patented it in 1875, but it has been much improved since its first appearance, and seems likely soon to be in use on all potato-growing farms.

Class VI.—Harvesting Machinery.

The annals of this Society have been made the means, in the hands of Mr. Thompson, of Alnwick, of throwing such a flood of light on that much-vexed question, the origin of the reaping machine, that a little retrospection may prove interesting in this place.

In 1780, the Society offered a gold medal, or £30, for a machine to answer the purpose of reaping or mowing corn, and renewed

this offer yearly for some forty years. In April, 1812, a Committee of the Society considered and described in their minutes a machine made by John Common, of Denwick, Northumberland, and forwarded on his behalf by Lord Percy as a claimant for the premium. This machine combined all the essential principles of the modern reaper, having reciprocating knives, open finger guards, a swathe delivery, and a reel for bringing the standing grain to the cutters.

It is well known that experimental reaping machines were made before the date in question, but these all had rotating knives, and were consequently failures. Mr. Plunkett showed such a machine at the Duke of Bedford's sheep shearing in 1804, and Salmon's reaper, an engraving of which is given by Woodcroft, appeared in 1806. Mr. Ogle, a schoolmaster at Newham, in Northumberland, had indeed devised a rotary machine as early as 1803, but, becoming associated at that time with Common, who was his neighbour, he abandoned his own ideas in favour of the reciprocating knife, and in the course of the next few years made experimental machines on this principle. Common made three different reapers in 1811 and 1812, but ceased from scheming on harvesting machines in the latter year, partly on account of the mechanical difficulties encountered, but chiefly because of the popular clamour against the machine. This, indeed, was so threatening that his trials had to be made secretly, and by moonlight, the Duke of Northumberland, who was greatly interested in the matter, assisting at more than one of these midnight essays.

In the course of their operations, both Common and Ogle had recourse to the Browns, father and son, of Alnwick, clever mechanics and founders, who substituted iron for wood in many parts of their machines, and, indeed, ultimately became makers of an improved form of Ogle's machine, which they sold to the farmers around, about 1822. In 1824, the Browns sold their business, and shortly afterwards emigrated to Canada, taking with them models of Ogle's and Common's machines. Later, they removed to Sterling, in the Cayuga County, New York State, where the father became a farmer, and so remained till his death in 1850.

Mr. McCormick, the reputed originator of the reaping machine, competed at the trials of harvesters held by the New York State Agricultural Society, in 1846, at Auburn, about twenty miles from Sterling, and he knew the Browns well. From them he received a model and description of Common's machine, which, there is now little doubt, was the progenitor of that shown by McCormick at the Great Exhibition of 1851. It was not till 1826 that the Rev. Patrick Bell, once considered McCormick's rival as originator, brought out his well-known reaping machine, which has come down to the present day unchanged, except in details, and whose principle of delivery, after suffering a temporary eclipse, is coming to the front again in the latest or sheaf-binding form of harvester.

More patents have been obtained for improvements in reapers and mowers than for any other implement. Between two and three thousand have been taken out in England, and nearly double that number in America; while the degree of perfection to which these difficult machines have arrived is very great.

The improvement of mowers, since their first introduction, has consisted in lightening the dead weight and moving parts of the machine; in perfecting the cutting apparatus so that clogging is impossible under all conditions of crop and soil; in the substitution of iron for wood in the framing, and in housing the gearing. In all these respects the mowing machine has been for some years a perfect tool, and recent improvements are so much mere matters of detail that they do not require special notice.

The case is different in regard to the reaping machine. This implement must not only cut, but deliver the grain, and the problem of how best to deliver indifferently wheat, oats, barley, and beans, long crops and short crops, wet and dry, standing and laid, is one that still engages the close attention of many clever inventors.

Although swathe delivery was the rule in all the early machines, the question of self-acting delivery in sheaf was not entirely neglected. Mr. Salmon, surveyor to the Duke of Bedford, whose name has already been mentioned, made a self-raking reaper as early as 1806, and although the machine itself was a failure, it embodied the principle of the revolving rake, now universal in that class of reaper. In America, Mr. Seymour, of Brockport, introduced a reciprocating rake in 1851, and the machine, improved by Seymour and Morgan, and patented in England in 1858, made a favourable appearance on light crops. In 1862, Messrs. Samuelson and Co., of Banbury, introduced the "Dorsey Reaper," an American

invention, which, being greatly improved by this firm, laid the foundation of all the modern self-rakers.

The Dorsey machine, however, did not size the sheaf, but threw the grain off at regular intervals without reference to variations in the weight of the crop. At the Manchester Meeting of the Royal Agricultural Society of England, in 1869, the Johnstone Harvester Company, of Brockport, U.S., first introduced a controllable self-raker, which was patented here in 1868. This machine was not suitable for English crops, and made no figure in the Manchester trials; but the principle of sizing the sheaf was correct, and in the course of a few years English manufacturers were compelled to adopt either the Johnstone switch, or some equivalent of this device, for placing the rakes under the control of the driver, and these machines attained a high degree of perfection before the problem of sheaf-binding had attracted much attention.

The idea of a sheaf-binding reaper is by no means recent. In 1849, Jacob Mann, of Clinton, Ohio, patented a machine having endless bands, which carried the cut grain into a receptacle, whence it was delivered at intervals in loose sheaves. In 1851, Watson and Renwick, of Chicago, brought out a sheaf-binder, which, in effect, was exactly like the string-binder of to-day. It failed from mechanical defects in the delicate tying apparatus, but it led to binding by hand upon the machine, a practice long successfully employed in America.

The first sheaf-binder ever seen in Europe was exhibited by Walter A. Wood and Co., at Vienna, in 1873. It bound the sheaf with wire, and was made on a large scale in the States, between 1875 and 1878. Other American makers were busy with the same problem, and although the five years which immediately preceded the introduction of the string-binder were experimental in character, probably 20,000 wire-binders, by various makers, were sold during that period in the States.

Meanwhile an outcry had been raised against wire, both by farmers and millers, and the Johnstone Harvester Company began experimenting with twine-binders, their first machine of this kind being shown at Bristol, in 1878. Although successful in light crops, this reaper was unfit for heavy grain; but the problem of binding with string instead of wire was fairly solved. Thereupon a crowd of inventors threw themselves upon the question, and the records of the Patent-office teem with applications for the protection of string-binding reapers. Numerous as the schemers are, however, only two self-binders are yet before the public, viz., the Wood and Appleby machines, both of American origin. Of these, the former is produced exclusively by Walter A. Wood and Co., working under their own patents, while the latter, which is public property in this country, has become a type, with slight modifications, for all the English makers.

It is beyond the scope of this paper to describe in detail so complicated a machine as the self-binding reaper, and the task is unnecessary, in view of the excellent illustrated account of the Appleby machine, which appears in Mr. Coleman's report on the Derby trials, published in the *Journal of the Royal Agricultural Society*. But it may be said, generally, that the cut grain is carried, in the first place, across the platform, and then over the drive wheel by means of endless webs. Here the stream of grain falls down an incline, until its passage is stopped by a bar standing vertically across its path. Against this bar the grain is "packed" until a bundle big enough for a sheaf is formed. Then the bar, which is arranged to give way under a certain pressure, moves and, in doing so, puts into gear the "binder," a curved arm which comes up from below, and after passing the binding string around the bundle, leaves its end in the grasp of the "knotter." Finally, this clever device first ties and then cuts the twine band, leaving the sheaf free to be kicked off the machine, by a pair of levers provided for that purpose.

It is too early, as yet, to speculate on the future of the self-binder in England. Probably not more than 150 of these machines have been set to work in this country, and they have still to be proved competent to deal with the unusually adverse conditions of English harvests. But in America and the Colonies they seem likely to supersede every other form of reaping machine. There are about 1,000 already at work in Australia and New Zealand, and more than 120,000 in America. Of the last, perhaps, 100,000 are string binders, a number startling enough when it is borne in mind that it is only about four years since this machine was introduced into the States.

Several patents have been taken out for, and a few machines exhibited, which follow the ordinary self-rake reaper and tie up the grain. The Johnstone Harvester Company were again

ahead of other competitors in this field, and their "Gleaner and Sheaf-binder," shown at Derby, has a practical appearance, but it is doubtful whether the disposition of the sheaves, as they are left by the self-raker, working in English crops, is regular enough for such a machine to operate successfully.

While the chief interest of harvesting implements centres in reaping machines, it must be remarked that haymakers have been much improved of late years, chiefly in details, by Ransome, Howard, Nicholson, and Jeffery and Blackstone. The first-named makers have introduced a tedder which knocks the grass out of the swathe by means of a fast back action, thus throwing the crop up behind the machine instead of over it, as usual. This method of tossing is sufficient for light crops, and does less damage to the hay. The last firm have added a hood to the old Ashby machine, which partially encloses the forks, and checks clogging in windy weather.

Horse-rakes, once a rough class of implements, are now admirably made tools. The teeth are constructed of steel, and their form has received great attention with the object of collecting large loads while giving a loose, light discharge. They are also made adjustable, so as to lightly skim, or closely rake the ground at pleasure. By the adoption of a balanced rocking frame, locked when at work and free when being raised, the effort of lifting has been reduced to a minimum, while seats have been added, together with an automatic delivery under the control of the driver.

Stacking machines are now universally employed, and are of two kinds. First, the "horse pitchfork," which takes the hay from the waggon and deposits it on the rick, and second, the "straw elevator," driven by a small horse-gear. In the latter machine the hay or sheaves are thrown from the waggon into the hopper, whence they are raised to the top of the stack by means of endless chain-rakes, capable of elevation as the rick grows in height. Attempts have been made to load the harvest waggon itself by means of machinery, but although a great many schemes for this purpose have been patented, very few have been reduced to practice, and loading machines may still be considered as among the harvesting implements of the future.

Class VII.—Machinery for Preserving Crops.

Recently, and for many years in succession, the English farmer has suffered grievous loss from continued wet weather occurring at the gathering-in period. The injury which grain crops sustain during a wet harvest is well understood, the corn market being sensibly affected by this cause, although the country no longer depends on home-grown cereals. But, in the case of hay, very few people have any idea what large sums are yearly staked on sunshine. As compared with ten or fifteen years ago, however, a larger portion of every British farm is now in grass, and a larger portion of that grass is mown for hay, while the total value of the hay crop of these islands is probably not less than twenty-four millions sterling. Any invention, therefore, which would make farmers independent of the weather during harvest time would be an immense boon, and this is what certain enthusiastic gentlemen say they have succeeded in accomplishing.

It happened, very opportunely, that Messrs. Sutton and Sons, the well-known seedsmen, offered a 100 guinea prize last year for the best machinery devised with this object, and the judges of the Royal Agricultural Society of England were accordingly engaged during many weeks at Reading in laboriously testing a quantity of tackle, which was submitted to them for comparison.

Two names are prominently before the agricultural world in connection with this subject; Mr. Gibbs being the advocate of drying by hot air before stacking, and Mr. Neilson of drying in the stack. The former gentleman has himself brought his invention so recently before this Society that it would be superfluous to add anything to his account of it; but Mr. Neilson's system may be shortly described.

The stack is built with a central cavity or chimney, which, however, does not run right through the rick, but is closed in at the top. Below, this cavity communicates, by means of an air-tight passage, with an exhaust fan placed outside the stack, and driven by a steam-engine. Hot damp air being thus drawn from the rick, the cooler and drier air of the outer atmosphere is supposed to find its way in all directions through the interstices of the hay or corn, which it cools in its passage.

This plan, though quite original with Mr. Neilson, who, in the most unselfish spirit, refrained from patenting it in order that he might benefit his fellow farmers, is by no means new. Forty years ago, Lord Kinnaird dried hay in the same way at Inchture, Carse of Gowrie, where, as in Scotland generally,

hay from the swathe is first made up into hand-cocks, and from these into "tramp-cocks," or "pikes," each containing about two tons, and from which hay is frequently sold. If the crop is to be stacked at home, the hand-cocks are carted to the stack-yard, where they are made into "tramp-cocks," pending the building of the stack.

It was upon such "pikes" that Lord Kinnaird's experiment was made, and in precisely the same way as that which Mr. Neilson now advocates. After this, numerous patents were taken out for the ventilation and drying of stacks. Thus Bellfort, in 1854, and Church and Hamlyn, in 1856, described a mode of drying similar to that exhibited by Kite and Co., at Reading. In the same year, Dray of London, patented Neilson's fan and stack-cavity, lining the latter with a perforated pipe. Dyson, of Tudhoe, patented the same thing in 1866, and finally Mr. Neilson re-invented stack-drying at a moment when a succession of wet harvests had attracted great attention to the subject. Nor have Mr. Gibbs's ideas been entirely unanticipated, Henry Saunders, of Staines, having, in 1853, patented the drying of grass and other crops on endless carriers, through which hot air was passed by means of a fan.

In view at once of its importance, and the enthusiasm with which this problem has been attacked by Mr. Gibbs, Mr. Neilson, and others, it is much to be regretted that no valuable results were obtained from either system at the Reading trials. The weather was just of the right kind to test the value of artificial drying, and the judges seem to have given great pains and an unusual amount of time to the inquiry. In the result they report that the Gibbs machine "failed to make hay of as good a quality as might have been made in similar weather without any artificial means;" while of the various adaptions of the Neilson fan, it is said that the work was "in no case satisfactory" upon hay, and "a disastrous failure" in respect of corn.

Ensilage.

Ensilage is the packing of green crops in air and water-tight pits called "silos." If the packing is rapidly performed, the forage evenly spread, covered with planks, and heavily weighted so as to drive out the air, any green vegetable matter will keep fresh for at least a year in a silo. As the mass becomes compacted together, fermentation is arrested, and on the pit being opened after some months, it is found full of excellent and appetising food, a kind of "sauer-kraut" for cattle, which can be made available at any period of the year.

The practice of ensilage is very ancient. It was known for centuries before our era, and probably had its origin among warlike nations, who, in the first instance, concealed their crops in this way to prevent pillage. Hannibal laughed at his opponents, during the second Punic War, for their ignorance of this method; and it is mentioned both by Euripedes and nearly all the Latin writers on agriculture.

But, as in case of stack-drying, "there is nothing new except the forgotten;" and the Americans, among whom ensilage is rapidly coming into extensive use, seem to think that it has originated quite recently in the States. It appears, however, that a M. Goffart, of Sologne, in France, published a work on ensilage in 1877, which was translated into English, and published at New York in 1879. M. Goffart himself began the practice of ensilage in 1852, but it was his book that formed the starting-point of the system in the States. The Vicomte de Chezelles is another well-known French agriculturist, who has for some time saved portions of his forage crops on this plan, while the Norfolk farmers who lately visited Holland, as narrated in the *Field*, saw it successfully working in the hands of the Dutch.

Already a number of patents, both American and English, have been obtained for silos, and various mechanical appliances in connection with them. The last, for the most part, refer to arrangements for compressing the fodder more closely and easily than can be done by dead weight; while the first are directed to the construction either of great iron tanks, or masonry towers, for the storage of corn, and to the fitting of these with elevators and creepers for turning and airing the grain.

It is easy to understand why a system which promises a supply of green food for stalled cattle in winter, should be eagerly welcomed by the farmers of the Eastern States of America, where there are no root crops, a short cut of hay, and a winter of such rigour, that every kind of animal must be housed. The American advocates of ensilage seem at present, indeed, rather extravagant in their expectations. It is spoken of as an "agricultural millenium—almost," "a new dispensation," and "as destined to work a revolution in the present system of dairy farming." As a matter of

fact, the cost of feeding appears to be reduced about one-half, and an acre of land in ensilage will keep one cow for twenty-four months, while, by the old system of farming, it would only do so for a year. Such, at least, is the testimony which Mr. Wolcott, of Boston, a great ensilagist, gave to Professor Rogers, M.P., who has lately investigated the subject in New England, and to whom the agriculturists of this country are indebted for the issue of some valuable Parliamentary papers on the practice of ensilage in the States.

Whether this system offers the same advantages in England as in America, is at present a question. On the one hand, an English farmer has roots and heavy grass crops, but no maize, which forms the staple of American silos. On the other, as the plans of Mr. Gibbs and Mr. Neilson attest, he is sadly in want of some means of preserving crops in wet seasons. Thousands of acres of hay are annually spoiled in England by rain; aftermaths are seldom secured, and, in Scotland, a vast amount of corn is lost every year from the lateness and wetness of the seasons. If it should prove that all this food can be saved in silos, then ensilage, although no "new dispensation," will probably do as much for British agriculture in the future as all the implement makers have done for it in the past.

Class VIII.—Barn Machinery.

The modern thrashing machine might well be called a product of evolution. It is the outcome of forty years of experiment, unaided by theory; the survival of the fittest results obtained from a long series of trials and errors, and combined in a complex piece of mechanism, whose many functions have been correlated with an extraordinary diversity of conditions by the labours of a generation of mechanics.

Thrashing machines are classified as "double blast," or finishing, and "single blast," or non-finishing machines. The operations performed by the former of these are:—

1.—Separation of the grain from the ear and straw.

2.—Separation of the grain from cavings, chobs, and chaff.

3.—Separation of the grain from dirt and seeds.

4.—Separation of the grain into different qualities.

So far as the first two of these functions are concerned, the finishing machine has been but little changed for a long period. It is in regard to operations Nos. 3 and 4 that recent improvements have been most numerous and important. A few years ago, there were no machines which could finish for market unless the crop was in fair condition, but perfect samples are now obtained from grain, no matter how foul or unpromising its condition.

A distinct cleaning and sizing machine, called the "second dresser," has been incorporated with the original thrashing machine. It consists of sieves, and a second blast, so arranged that any dust, dirt, seeds, or chaff, not extracted in the first dressing, are cast out, while uncleaned grain is returned to the riddles, and passed a second or even a third time through the machine. Meanwhile, such grain as has been thoroughly cleaned, falls into a revolving screen of three different meshes, whence it is discharged, either as first, second, or third quality, into sacks, ready for market. The single blast machine has no second dresser, and does not finish for market. It remains very much the same as it was many years ago, and is still popular with farmers who thrash for the granary, or before their corn is in a fit state for marketing.

For hot climates, where straw is unfit for the food of live stock until it has been crushed under the feet of horses or cattle, as it was upon the primitive thrashing floor, Messrs. Ransomes and Co. have introduced a straw-bruising apparatus. The straw, as it comes from the shakers, falls upon a roller furnished with knives, which cuts it into rather long chaff. This chaff is fed into a concave, where it is crushed by a second roller armed with blunt pegs, and whence it finally issues, thoroughly bruised, and in a fit condition for food. Messrs. Clayton and Shuttleworth, on the other hand, adopt the plan of placing a large chaff-cutting engine beneath the straw shaker, and driving it from the machine. Herein the loose straw is cut to any desired length, impurities are riddled out, and the chaff delivered into sacks ready for transport.

By an Act of Parliament, passed in 1878, for the prevention of accidents in thrashing machines, makers are now obliged to protect the mouth of every thrashing machine with such a guard as effectually fences off the drum from the possibility of anyone falling into it while at work.

Previously to this, however, in 1874, the Royal Agricultural Society of England had

offered prizes for drum guards, and in 1871, Wilder, of Reading, patented a safety feed, which has since been adopted by several eminent makers. This apparatus is, in effect, a small straw shaker, which delivers into the drum mouth, and is fed by an attendant, who himself stands in a place of safety. Above the shaker hangs a spiked rake, under whose teeth nothing thicker than a layer of grain can possibly pass. Attached to one of Clayton and Shuttleworth's machines, this simple but excellent device took the first prize at the Royal Agricultural Society's competition at Taunton in 1875, when a prize of £10 was also awarded to Messrs. Marshall's "feeder."

This consists of a spiked barrel, fed from an inclined board. Beneath the latter three saw-toothed discs revolve, and the board itself is suspended by springs in such a manner that the weight of a sheaf depresses it sufficiently to allow the discs to protrude and cut the band. The loosened sheaf is then carried forward by the spiked barrel, until it reaches a line of oscillating forks, by which it is spread out evenly just before entering the concave.

Drum guards proper are now very numerous, and the subject of many patents, but they all depend on one of two principles. Some makers think, with Messrs. Robey and Garrett, that there is no danger of accident to the feeder so long as he is in his box; and it is only when he is out of it that there is any possibility of his falling into the drum. Their guard consists simply of a cover, which always remains closed until the feeder gets into his place, when his weight depresses the bottom of the box a little, giving movement to suitable levers, and opening the mouth of the machine. Others arrange matters in such a way that if any undue pressure comes, either upon the feeding board, or a curved hood which half covers the drum opening, the latter is instantly closed by a self-acting shutter or flap.

The use of an elevator, for carrying the straw as it issues from the shakers to the top of the straw-rick, has long been universal; but in 1879, Messrs. Nalder and Nalder exhibited a thrashing machine and straw elevator combined, which is a step in advance of the old system. The separate elevator is cumbersome to transport, and wastes much time, especially on uneven ground, in its adjustment and fixing. But the Nalder Elevator is an integral part of the machine, which, swinging around a pivot like a crane, delivers the straw in any direction, while it is arranged to pack easily and snugly on top of the thrasher when travelling. Still more recently, the same firm has patented a thrashing machine, in which the straw-shaker, jog-board, and riddles are all driven from the same crank shaft. This dispenses with the usual shoe-crank, and saves a number of bearings, while the work is done equally well.

In the interesting comparative museum of ancient and modern implements, which the Royal Agricultural Society of England brought together at the Kilburn Show in 1879, there might have been seen a dressing machine, by Henry Cooch, of Harlestone, which had been in use for 79 years, and was still a serviceable tool. Venerable as it was, however, this machine bore a strong family likeness to the latest dressing machine by the same maker, which the judges had chosen as the representative of modern practice, and there is, indeed, little to be said about recent improvements in connection with this class of implements.

But in 1867, Mr. Childs introduced from America a very successful machine known as the "Aspirator," wherein the fan blast of the ordinary winnower is replaced by an exhaust, acting in conjunction with riddles, for the cleaning and separation of grain. Since that time great improvements have been made in exhaust dressing machines, chiefly, however, in connection with milling; but Mr. Childs has not escaped some of that sincere form of flattery called imitation, which is the best testimony to the efficiency of his machines for dressing grain.

Class IX.—Food-preparing Machines.

There is very little to be said of recent improvements in this class of agricultural implements. The chaff-cutter, grist-mill, oil-cake crusher, and turnip-cutter, are all respectable old-fashioned machines, so long settled down upon their lees that they attract but little attention at agricultural shows, even from intending buyers.

Some half-dozen patents, however, are annually taken out for safety appliances in chaff-cutters, and one of these, introduced by Crowley and Co., of Sheffield, in 1878, has some novelty. The machine is provided with a lever, which throws the feed-rolls in and out of gear, and controls the speed-gear for determining the length of chaff cut. In case of a man having both hands caught in the feed, his body would be drawn against the lever in question, whose movement instantly stops the

rolls. A further push with the shoulder against the same lever reverses the feed and frees the man, who in ordinary cases would be quite helpless until assistance arrived.

Among corn mills for the farm, two machines have lately come to the front, viz., the "Beaufort Hunt Mill," by Messrs. Lister and Co., of Dursley, and a new mill by Messrs. Nicholson, of Newark. The first is an old implement, improved by more truthful turning and more careful grooving of the old-fashioned roller and breast. The second mill belongs to the conical class, the runner being bell-shaped and mounted on a vertical spindle, while the kibbling and grinding surfaces are so far apart when kibbling as to let the cracked grain pass between them without rubbing.

Oilcake breakers present absolutely no new features to remark upon, while, with regard to root slicers, it is now nearly fifty years since Gardner, of Banbury, patented the well-known turnip-cutter which still bears his name, and remains the best machine of its class among a hundred rivals. This is the only agricultural implement which seems incapable of improvement. Unlike the thrashing machine, it is no "survival of the fittest," but sprang from the head of the Oxfordshire ironmonger like Minerva from the head of Jove, complete and invincible.

Class X.—Hay and Straw Compressors.

In consequence of its bulk, the transport of forage is very costly, and an important branch of agricultural commerce suffers accordingly. Hay-presses, it is true, are used by shippers, but have never come into vogue on the farm, partly, perhaps, because they injure the hay, and partly because they give great opportunities for putting inferior stuff into the bale.

The Pilter press, which was shown for the first time at the Paris Exhibition in 1878, and received the silver medal of the Royal Agricultural Society of England, at Kilburn, in 1879, seems, however, likely to prove a farmer's implement. In this machine the hay is forced into a cylindrical chamber by the action of two conical rollers, which divide the stuff into bands, and wind these around each other, without injury to the fibre, until the cylinder is filled with a compact mass of hay. This issues, as it is formed, like a sausage from a sausage machine, pressing against a plate whose resistance is adjusted according to the density required in the bale. When about three feet of compressed hay protrudes, the machine is stopped, and the bale tied up with wires. Each bale weighs about 2 cwt., and its density varies from 12 to 25 lbs. per cubic foot, 18 lbs. being recommended for conveyance by rail, and 25 lbs. for shipment.

It is no uncommon thing to find bales of pressed hay in which the centre bears no resemblance to the outside, but with Pilter's press this is impossible, as no one can tell in what part of the bale any given portion of hay will ultimately be found, nor can foreign matters, such as stones, be introduced, while the cylindrical form of the bale allows of its being easily handled.

A silver medal of the Royal Agricultural Society of England was awarded at Derby, in 1881, to Dederick's "Perpetual Press," an American invention, recently introduced into this country by Messrs. Ladd and Co., of London.

The Dederick press consists of three parts:—

1. A vibrating beam, with packer for doubling and forcing the hay into the mouth of the compressing chamber.
2. A reciprocating traverser, or hay-piston, for forcing the doubled mouthful of hay into the compressing chamber, and
3. The compressing chamber itself, in which self-acting springs allow the ingress of hay, put prevent its expansion backwards.

The bales are rectangular in shape, are bound by wire, and can be made of any length.

This press made a very favourable impression at Reading, where it compressed 42 lbs. of hay into one cubic foot, the exhibitors claiming that they could compress 45 lbs. into a cubic foot, or a ton of hay into a ton of measurement. "It has yet to be seen," the judges remark, "whether such a machine can be applied to the saving of green hay in the field. The exhibitor claims that the compression would prevent fermentation, even if hay were packed in a much greener state than it is generally stacked, and this opinion was shared in by one of the judges, who is an extensive hay-seller, and who believes that, through its agency, hay might be secured from the field in greener and, therefore, more valuable condition than when stacked and sweated in the usual way. One machine, capable of pressing 2½ tons per hour, could deal with the crop as rapidly as by ordinary stacking. The hands employed would be less numerous, and when the market is the destination, such a scheme seems very practicable."

Class XI.—Milling Machinery.

Milling, although one of the oldest mechanical processes in the world, is undergoing a complete revolution at the present time. Up to within ten or twelve years ago, the system of milling in use, both in this country and America, was the familiar process which consists in passing the grain between the upper and nether mill-stones, set closely together, so as to crush at one operation all the interior of the wheat-berry into flour, while the exterior skin, or bran, is spread out into flat flakes.

A skilful miller endeavoured to break the bran as little as possible; first, because fewer of its particles would then find their way into the flour; and, second, because large flakes of bran are commercially more valuable than small. After grinding, there was nothing to do but separate the flour from the "offal" by sifting or "dressing" the meal, the whole system having been modified in nothing except details since the day when two women first ground at the mill.

"Low, or flat grinding," as it is called, is well adapted to wheats with tough skins, such as are grown in England; but the wheats of Eastern Europe and Western America, on which this country now largely depends, are of a different character. These are very hard, and have such extremely brittle skins, that any attempt to grind them in the usual way results in the bran breaking up into very fine particles, which cannot afterwards be separated from the flour by any process of dressing.

So long as the public was not fastidious in the matter of its bread, the dark flours which "low grinding" produced from hard wheats, found a sale on the Continent. But the taste of consumers has grown more refined of late years, so that, first the Austro-Hungarian, and then the American millers found themselves obliged to march with the times. Hence arose the practice of "high-grinding," or setting the mill-stones just so far apart that they crack the wheat-berry into small particles, but do not grind it into powder. The cracking is repeated several times, and the products, called middlings or "semolina," are winnowed after every operation, until all the bran has been removed. Nothing then remains but granular fragments of the interior of the wheat-berry, which are crushed down under "low-grinding" stones into flour.

By this system, at least three qualities of flour are produced, viz., that from the first grinding, the ground middlings, and a flour obtained by finally grinding the bran. The first of these flours contains all the impurities which cling, even after careful cleaning, to the wheat-berry. The second is finer and whiter flour than can possibly be produced by low grinding; while the third is a coarse and comparative valueless branny flour.

The success of high grinding depends on finding a market at a comparatively high price for the fine flour; and, a dozen years ago, Austro-Hungarian flours, produced from semolina, were selling in the English market at from 10s. to 20s. a sack more than the home made article. For a long time, indeed, the continental maker was able to dispose of all his fine flours abroad at a high price, while he found a home market, at not too low a price, for the inferior bran flours.

But this state of things did not last. America adopted the "new process," and exploited it with her usual energy. Every miller who had a middlings purifier launched into making middlings flour regardless of yields, for, at the prices then ruling, he could afford to ignore the quantity of wheat it took to make a barrel of flour. The demand for very fine flours is, however, limited, and in the course of a few years the market became glutted, the price of "patent flour" was pulled down, and the question of yields forced itself again on the miller's attention. Then came modifications of the "new process," and, finally, the system of "gradual reduction," concerning which the minds of millers are greatly exercised at this moment.

It is admitted on all hands that this is the process under which the highest quality of flour can be manufactured, but it is complex in working, and its complete adoption would seem to threaten the time-honoured millstone itself with extinction. British millers naturally hesitate before taking a step which involves erecting a perfectly new plant; but something was gained by the party of revolution when they persuaded a number of these gentlemen to pay a visit to Buda-Pesth, and see with their own eyes what was being accomplished there by means of roller mills.

Roller mills date back to 1820, when three of them were built on the Continent, one at Vienna, one at Paris, and one in Switzerland. All three were failures; but, ten years later, Mr. Sulzberger, of Frauenfeld, brought out a new roller mill, which created an extraordinary sensation among Continental millers. Rollers were erected throughout Germany, Italy, and Austria. Everyone thought that the days of

the millstone were numbered, and, indeed, there was something to justify these anticipations. The new mills made good flour and good profits, yet before 1840 they had, all but one, reinstated their old millstones. Several reasons have been given for this, the most probable being that rollers were too indiscriminately used for all kinds of work; but, be the cause what it may, roller mills were lost sight of for a long time after the fiasco of 1830-33.

A new revival in favour of roller-milling is again in full blast, and it now becomes necessary to describe the process of gradual reduction, as it is carried out under this system. The wheat, having been first cleaned, is led between a pair of fluted and differentially speeded rollers, which are set so as scarcely to allow the grain to pass through them. The corn is thus slightly cracked, after which it is purified, for the removal of any dust that may have been disengaged. It next passes between another pair of rollers, more closely set, which break the grain again; the resultant meal is sifted, and some semolina, accompanied by a little break-flour, is obtained. These operations are repeated again and again, but always between closer rollers and with finer sieves, until most of the inner part of the berry has been freed from the bran.

A meal is thus produced, which consists of middlings of various sizes, particles of bran of corresponding sizes and break-flour. The last is sifted out, and then the semolina is winnowed, in order to separate out the light particles of bran. But, as the amount of wind which would suit the larger fragments would blow away the smaller ones, the meal is first sized, by wire cloths and silk gauzes, into a number of different qualities, and these, after being purified of their bran by air currents of suitable strength, are separately crushed into flour between smooth rollers under considerable pressure. The system is a delicate and intricate one in comparison with the simple process of "low-grinding," but the fine flours obtained, are of the highest quality, and, where a suitable market can be found for them all, it gives good commercial results.

Rollers are almost always made of chilled cast iron, and are fluted, finely grooved or smooth, according to the functions which they fulfil in milling. A few years ago, however, Mr. Wegmann, a Naples miller, introduced rolls of unglazed porcelain as rivals to chilled iron. Their surface has a texture similar to, although much finer than that of French burr-stones, but the proper place of porcelain in rolling-milling is to reduce the finest or branless semolina into flour. When bran is present, the very grinding power of the porcelain reduces it to such minute particles, that by no process of purification, can these be afterwards separated from the flour.

Before passing on to describe a recent American invention, called the "Jonathan Mills" system of gradual reduction, it is needful to say a few words about the wheat-berry, a close consideration of whose physical peculiarities is said to have suggested every step in this process.

Not to be too minute then, a grain of wheat consists of an outer coating of bran, which is itself composed of five layers of cells; an inner coating, called the perisperm, containing gluten; the endosperm, or starchy kernel and the germ, or embryo of a future wheat plant. The endosperm and the perisperm, the starch and gluten, are the valuable parts of the wheat, and the object of scientific milling is to empty the berry of these as completely as possible, casting out the germ, and leaving the coat of bran, as far as possible, intact. But there is something else, not a part of the wheat-berry, which it is also very desirable to eliminate from the flour. Every wheat-grain is deeply cleft by the "crease," and this narrow notch is always filled with dirt, which, being irremovable by any cleansing machine, is ground up in the flour, whether by millstones or rollers.

The germ, and the crease contents, the system under review claims to remove before the actual work of reduction commences. The wheat is cleaned very gently, and by means of brushes, in order that the bran may be kept unscratched, so as better to withstand abrasion while the berry is in course of reduction. The cleaned wheat passes into the "Degerminator," a machine consisting of two metal discs, whose peripheral faces are furnished with rounded corrugations set at such a distance apart that the kernel, when lying flat, cannot quite pass between them. A slight pressure from opposite smooth surfaces upon wheat berries in this position, causes them to split through the crease, liberating the dust within it, and, if the inventor is correct, disengaging the germ at the same time.

This operation is repeated a second time, and after the break flour, which is foul with crease dirt, has been sifted out, there remains only coarse clean groats. These are reduced to semolina by passing through successive mills,

essentially similar to the "Degerminator," in construction, but set progressively closer, until the bran had been cleaned. Three reductions are found enough for this purpose, and, the flour and middlings resulting from these having been bolted in the ordinary way, the latter are purified and reduced to flour, either by millstones or rolls, at the discretion of the miller. The bran from the last reduction is finally ground, either by millstones or rolls, and the flour and middlings therefrom treated in the usual manner.

The Middlings Purifier is one of the most important of all recent improvements in machinery connected with milling. By its means the semolinas, which it is the object of gradual reduction to produce, are freed from the small particles of bran mixed up with them, and are themselves separated, according to their densities, into lighter and heavier samples. No sifting can accomplish this, because the middlings and bran are often of the same sizes, although differing in specific gravity.

In the ingenious exhaust machines now universally employed in Austria and Hungary, a stream of semolina falls through a vertical pipe fitted with baffle boards, so arranged as to cause the stream to cross and re-cross the pipe repeatedly, while a current of air is sucked upwards through the latter by means of an exhaust fan. The strength of the current can be regulated so as to carry away the whole stream of semolina, or only the lightest particles of bran, every falling fragment being thus weighed and re-weighed many times in a delicate pneumatic balance.

Another type of machine which finds much favour in England and America, where the semolina is small, is well represented by Mr. Child's "Excelsior" Middlings Purifier. This is a combination of silk riddles and exhaust. The former are given a downward beat by the action of a pair of cams, which, compressing four india-rubber springs at the corners of the riddle-frame, cause the riddles to rise and strike against a stationary buffer, and the sudden stopping of the sieves, throwing the middlings into suspension, enables the exhaust to act with the greatest effect on them. The air current, which sweeps upwards through the silks, carries the lightest particles away altogether, but is not powerful enough to prevent the heavy granules of semolina falling through the riddles. The branny particles, however, which are lighter than the semolina, are kept floating on the silk, through which the air current prevents them from passing, and are ultimately discharged as overtails.

There is a third class of purifier in which currents of air are employed in connection with centrifugal force, but want of space forbids a long description of it. An electrical purifier, the invention of Messrs. Smith and Osborne, was patented in 1880, and shown at the milling exhibition of 1881. It created some stir there, but has not been much heard of since, and it also may be dismissed with a passing notice. The purification of wheat by means of magnets from particles of iron, such as nails and wire, is another important modern improvement in the practice of milling, and one that finds a wide field of usefulness in the States, where the wire-binding reaper is in extensive use.

A word or two must suffice to indicate what has been done of late years in dressing machines. Wire cylinders and brushes gave way thirty years ago before silk screens, which, though very effective in work, are cumbrously long. Shorter cylinders have lately been introduced, containing revolving beaters, which throw the meal repeatedly, but lightly, against the silks, and thus greatly expedite the operation of dressing.

If it is thought that I have dwelt too long, in a paper of general character, upon milling, my excuse must be found in the immense importance of this industry, and the sweeping character of the changes which are just now threatening its operations. The last have been sketched in very imperfect outline, while, with regard to the first, a great authority has recently said that Great Britain consumes annually fifty-six million pounds worth of wheat, which is converted into flour by eighteen thousand pairs of stones, employing engines of one hundred and twenty-five thousand horse power. This is, indeed, a great national industry.

Class XII.—Dairy Appliances.

Twenty years ago, scarcely any foreign butter was imported into this country, but now, not a hundredth part of the butter eaten in London is of English origin. Great Britain, indeed, buys £12,000,000 worth of butter every year from the foreigner, a sum equalling in value all her tea trade, or half her sugar trade, and being nearly one-fifth of her greatest import—corn. Yet the climate, the soil, the price of cows, wages, and the cost of transport, are all in favour of the native dairyman who, within twenty years, has allowed a trade equal to that in tea to slip through his fingers, half of it

having been surrendered during the last ten years.

Mr. Allender, of the Aylesbury Dairy Company, and Mr. Jenkins, secretary of the Royal Agricultural Society of England, have made it very clear how this has come about. The English farmer makes his two or ten dozen of butter once or twice a week, and sends it, say, to the London market, where the retail butterman must go, very early every morning, to make a selection from many hundreds of flats, each differing in quality from the other, and not very temptingly displayed in wrappings of cloth, or even old newspaper. Butter from Normandy or Denmark, on the other hand, comes forward in a very different way. Agents attend the local markets, and buy all their produce from the farmers, whom they keep advised of the qualities in vogue. This butter goes to the factory, where it is first mixed by machinery, and then put up, nattily papered, in boxes holding a dozen 2 lb. rolls. The contents of every box, distinguished by a given brand, are all exactly alike, so that the retailer can order from day to day, with the certainty of getting just what he wants, without any expenditure of time or trouble.

Dr. Voelcker has said that the foreigner beats the English dairyman, because he makes a better article; but foreign butter of equal quality commands a higher price, and finds a readier sale than English, because of its more marketable condition. The Rip Van Winkles of British dairy farms are at length awakening to this fact, and, finding the horse gone, are looking around for help to shut the stable door. The Royal Agricultural Society of England is, indeed, already fully alive to this great national loss, and made an excellent move, four or five years ago, in establishing a working dairy as a feature of its annual shows. To glance at the most important apparatus exhibited at one of these, is to epitomise recent improvements in dairying, and to sketch the history of a revolution, whose origin, it must unwillingly be confessed, is Continental and American.

The separation of milk from cream, hitherto effected slowly by gravitation, is brought about instantaneously by means of the centrifugal separators, of whose many forms the Laval machine, exhibited for the first time in England at Kilburn, in 1879, is the best known type. The milk is tanked as it comes from the cow, and runs through a tap into a spheroidal vessel, about a foot in its larger diameter, which rotates at a speed of 6,000 or 7,000 revolutions per minute. The heavier milk is at once thrown outwards towards the circumference, while the lighter cream remains nearer the centre, and each is drawn off from its respective zone by suitable outlet pipes. Cream is separated at the rate of sixty gallons an hour by the Laval machine, and still more rapidly by some others, the action being continuous so long as milk is flowing from the tank into the separator. By the use of this machine no time is lost in setting, the separation being effected immediately after milking, and only an insignificant per-centage of fat is left in the skim-milk.

Where the centrifuge has not yet been adopted, either Cooley's American or Swartz's Swedish setting vessels are rapidly replacing the old shallow pans. The theory that shallow setting promotes quick rising is exploded, while it is now well-known that the souring of milk is due to the development of germs which are always floating in the atmosphere, and are sown, like seed, to flourish when they fall on suitable soil. Of such a soil the shallow pan exposes a very large area, while the Swartz and Cooley cans, being deep and narrow, expose but little. The latter are cylindrical in form, and closed with covers, containing air, the whole being submerged in water of 45° to 55° temperature. The Swartz cans are narrow and deep ovals immersed in, but not covered by, cold water, and having no lids. By the American plan, sweet cream can be obtained whether in a clean dairy or dirty scullery, and both systems protect the milk from taking up either germs or flavours from the atmosphere. Milk was, indeed, kept in Cooley cans for sixty-seven hours in the working dairy at Derby, the temperature of the air being 80°, and found perfectly sweet at the end of that time.

It has long been known that if milk is artificially cooled immediately after leaving the cow, it will keep sweet much longer than if allowed to cool naturally, especially in hot weather. This is obviously because the floating germs, to which allusion has already been made, find in the warm milk just the seed-bed they require for rapid development, while they do not flourish in a cold, even if suitable, soil. Lawrence's Refrigerator is consequently much used in the best dairies, and, where a constant supply of cold water is at hand, is a most useful adjunct either to the mechanical cream separator, or to the immersed setting cans.

Of recent improvements in churns there is

little to be said. A number of excellent patterns await the dairyman's choice, and new forms are constantly being introduced, but as they illustrate no new principles, they may be passed by without further notice here.

The case is different with the "Butter Worker," a device to which the French and Dutch owe much of their trade, because it enables them to amalgamate the butters of many farms and supply a constant quality to the factor. In its best-known form, this machine consists of a revolving table, sloping from the centre to the circumference, upon which the butter is worked under a conical fluted roller, the expressed water and buttermilk flowing away by a peripheral channel. The butter is brought again and again to the roller by the attendant, using a pair of wooden "hands," and from first to last it is untouched by the fingers.

The appliances for scientific dairying are now, thanks in a large measure to the Royal Agricultural Society of England, before British farmers, but something remains to be done before they will win back the trade which the foreigner has taken away. Either farmers must associate and establish their own butter factories, or middlemen will do so, as they have done in France. A move has already been made in both directions. Mr. Carrick has started a butter dairy near Carlisle, buying milk on a large scale, producing a very even and saleable sample, and it is understood, doing prosperously. The "Gillingham Dairy Farmers' Association," on the other hand, comprises eleven farmers, who send their milk to a common centre with excellent results as to profits, and a great diminution of working expenses in comparison with those of an ordinary dairy.

A trade of twelve millions per annum is not to be permanently lost without an effort. The economist and the engineer have shown how it may be recovered, and it remains for farmers, having realised what a mine of wealth others have found in dairying, to take a hint from the old saw, "*fas est et ab hoste doceri.*"

Class XIII.—Poultry Farm Appliances.

The link between poultry farming and machinery is very slight, and it is, besides, unnecessary to describe such well-known devices as the hydro-incubator, the artificial mother, and the feeding machine, which, indeed, are only introduced here in order that a subject, interesting in itself, and of great agricultural importance, should not be dismissed without remark.

It appears, from trustworthy statistics published last year, that there are forty millions of fowls kept in France, which produce poultry for the table whose annual value is six millions of pounds sterling, and four thousand millions of eggs, worth ten millions sterling at the lowest computation. One-fifth of all the eggs laid in France are sent to this country, which pays to foreigners for eggs and poultry the astounding sum of eight millions annually.

Here then, are three imports, viz., butter, eggs, and fowls, whose combined value is not less than twenty millions. That sum equals the whole export trade of this country in wool or iron, which, next to cotton manufacturers, are its chief branches of foreign trade. It is one-third of its largest import, corn; one-half its next largest, cotton; nearly equal to the whole import of sugar, and nearly double the whole import of tea,—and the British farmer has thrown it away!

It is nothing less than a "national disgrace," says one of the reporting judges of Kilburn Show, "that whilst the import of eggs and poultry in the United Kingdom has reached the enormous sum of £8,000,000 in one year, we have not a quotation of English eggs in the London market, which is supplied principally from France, but also from Canada and the States."

France owes her supremacy in poultry farming partly to the fact that she is a country of small proprietors, but chiefly to the more economical and minutely industrial character of her farmers. They understand that successful poultry farming is an art requiring care and skill, like the rearing of cattle or the growing of grain, and they treat it accordingly. Fowls, on the other hand, are only an ornamental feature of an English farm, where they picked up a living at the barn-door in the days of the flail, an implement which the agricultural engineer has abolished, without the farmer having initiated a corresponding change in his system of poultry keeping.

If stock were now bred, fed, and tended as it was in the days of the flail, we should hear that stock farming, like poultry farming, "does not pay." But in regard to the production of meat and wool, old plans have given way to new, and it is because these are vastly superior to the practice of a past generation, that stock-farming is now the most profitable part of a farmer's business.

If, in a time when there is much wringing of

bucolic hands, the British farmer thinks a trade of £8,000,000 a-year worth attention, he may find it in poultry. That he will have to pay an apprenticeship fee before he can compete with the foreigner goes without saying, but the quoted figures prove to demonstration that the business is worth it, and fortunes may yet be made in England out of well-managed dairy and poultry farms.

In this, as in all other matters connected with his calling, the native farmer has the great advantage of access, through the Royal Agricultural Society of England, to the best and latest intelligence upon every subject, whether closely or remotely connected with agriculture. To the great agricultural societies, indeed, he owes, either directly or indirectly, many of those improvements in agricultural implements to which attention has been drawn this evening. For, whatever may be thought of the prize system as a mother of invention, there are not two opinions about the stimulating effect upon implement makers of annual agricultural shows. The motto of the English Society—adopted at a time when there was much more practice than science, both on the farm and in the workship—has indeed become that of the agricultural engineer; and a new industry, owing nothing to the absence of competition, awaits British agriculture whenever it can be fully and fairly characterised as "practice with science."

DISCUSSION.

Mr. RANSOME said the fact that Great Britain was the workshop of the world for agricultural machinery, must be very gratifying to every Englishman; but they all knew that, what with hostile implements and hostile efforts that were being made in other countries, it became every year more difficult for the English manufacturers to maintain the position they had so long held in that respect. They continued, however, to hold their own, and he was quite sure that any other country which might take that trade away from England would be well worthy of the success they achieved. Other countries had a great deal to do before they could make headway against England, even in protective markets, and in neutral markets it was quite impossible that they could do so. There was one point upon which Mr. Pidgeon had not touched, and that was the extent to which theory had to give way to practice in the operations of agricultural machinery. The mechanic might know perfectly well how to produce in his factory a very high result from a certain machine, but it was quite another thing to put the machine to work, say, on the Steppes of Russia, and get it to work successfully there. They must consider, in all their operations, not merely their own knowledge and capabilities, but the knowledge and capabilities of the users of their productions. Mr. Pidgeon had himself contributed very largely to the success of mowing and reaping machines, and those machines had given very great and valuable results, and had enabled corn to be brought to the London market in a way which would have been impossible had it not been for those successful practical results. The progress of agricultural machinery he (Mr. Ransome) considered was, to a great extent, due to steam navigation and the electric telegraph, by which the whole world was knitted together, and by which, if any improvements were made in any part of the world, they were speedily communicated to the other parts. He thought it would be the wish of all those present that the success which had hitherto attended England in this branch of industry might continue, and he trusted that when the present cycle was exhausted, and they came round again to the time when the Society wished to chronicle the progress of the next fifteen or twenty years, they might have someone who would be able to shape the outline of a story as full of interest as Mr. Pidgeon had now given them, and which, in all its details, was strictly true.

Mr. NICHOLSON said he wished to correct Mr. Pidgeon in an error he had made, as to the *locale* of Mr. Wilder, the inventor of the self-feeder, which was adopted by Clayton and Shuttleworth. Mr. Wilder was a farmer, and came from the neighbourhood of the Vale of Neath, and not from Reading.

Mr. CROSSKILL endorsed the remarks of Mr. Ransome, as to England being the chief country for the production of agricultural machinery, though the Americans had given them a few tools for which they owed them a great deal. It was, however, a gratifying fact that there was existing this large industry, which had attached itself almost exclusively to this country, and he had that faith in the ingenuity, perseverance, and talent of his countrymen, that he believed in years to come they would see as glorious an improvement in this industry, as Mr. Blagden had recounted of the past.

Mr. SHERBORNE said that, as a Judge of the Royal Agricultural Society, he had had an opportunity of seeing all sorts of agricultural implements, and of forming an opinion as to their capabilities, and not being restricted as to funds, he had always availed himself of the opportunity of purchasing such implements as he thought would be valuable to him, but it was a sad commentary on what had been stated as to the prosperity and wealth of the agricultural implement industry to think that that industry was ruin to the agriculturist. At present all the farmers were on the brink of ruin. He had been using capital for the last 12 years; and though he was sorry that such should be the result, he could not regret that the agricultural implement

makers had made fortunes. They had worked hard, and no doubt for the benefit of the farmers, but there was one complaint which he had to make against them, which was that they would not sell to a farmer direct any implement, but insisted on his buying it through an agency, which cost him from 20 to 30 per cent. more.

After a few remarks from Mr. TURNER,

Mr. BOTLY said he was old enough to remember the agricultural riots fifty years ago, and he thought they might congratulate themselves on the altered state of things which existed now. At that time the agricultural labourers were banded together, and went about destroying all the machinery they could—a course of action which ended in bloodshed. He could bear testimony to the fact that those farmers who employed most mechanical power employed also, and at the best wages, the greatest amount of manual labour, and, compared with others of their class who did not use much machinery, were more forward in every respect. Their labourers were better men, better educated, and did their work better; their wages were better, and their houses were better, and the produce of the land was much increased. He knew, himself, from experience on a farm of his own, that by employing mechanical power he increased the produce of wheat at least 50 per cent. He thought, therefore, they were much indebted to the agricultural implement makers for what they had done.

Mr. SMYTHE, in alluding to the question of competition with foreign countries, thought that if they could maintain their quality, and get foreigners to buy that quality, they could hold their own in England. They were, in fact, holding their own, because foreigners could not make the same article. When, however, they came to a more rudimentary class of machinery, which foreigners could make, then that was where Englishmen felt the pinch. He had come into contact all over Europe with a class of maker who made a certain article which would do its work, but still, he maintained the quality was not the same as that made in this country. Not long since he received a letter from a correspondent in Silesia, as to some drills, in which he stated that he could sell his (Mr. Smythe) drills if he could make them at German prices. They would not do this in England, and that he considered was a difficulty which they would have to encounter. Foreigners were satisfied with a second-class article, and we would not stoop to make that article, and thus we were apt to be driven out of the field. With regard to the question of American machines, he hoped that the Americans would not adopt free trade, because he was sure they could not compete with us, quality for quality, as far as the English class of machinery went. They were already beginning to find that the American machines were not what they were; in the Colonies they were beginning to find that the American drill was not the drill which would do the general work of the farm. It would drill grain, and, by a considerable amount of labour it might be made to drill other things, but still it could not compete with the English drill for its general adaptability to the work of the farm. Generally speaking, in Europe, they had not much to fear, and as long as they did not put a very high duty upon our goods, we could maintain our own. In trading in France he found they could hold their own, because they would have a good strong article; but where they had to compete in a country where the people were content with a weak article, which they did not mind renewing at frequent intervals, it would be a difficult task for the English manufacturer to stand his ground.

The CHAIRMAN, in proposing a vote of thanks to Mr. Pidgeon, said that when he (the Chairman) was a younger man, he was frequently one of the judges of machinery at the Royal Agricultural Society's Shows, and the experience which he there had of the ability of the makers of agricultural machines, and of the utility of the Royal Agricultural Society itself, had been impressed upon him in a manner which he should never forget. He had stated in many places that the way in which the Royal Agricultural Society, by its shows, prizes, and publications, had stimulated mechanical engineering, would be inconceivable to anyone who had not witnessed it. Under that stimulus, agricultural engines had produced non-condensing engines for trial, which had given economical results as high, if not higher, than the present average of the Cornish pumping-engine. By that statement he did not mean to say economical results as high as the best of the Cornish pumping-engine, but that the Cornish pumping-engines grouped together did not give so high a result as that obtained by the best of the trial engines at the Cardiff show. It had been objected that though these results might be obtained in trials, they could not be maintained in practice; that might be the fact, but still that was the standard to work up to. It also might be true that these machines were too delicate for ordinary work, but having that standard, they should try, with an apparatus which was not too delicate, to attain to that result as nearly as was possible. He knew the difference between the value of these machines; you might have two machines equally well made, as far as handicraft was concerned, equally well proportioned as regarded the strength of their parts, and yet one might burn three times the amount of fuel that the other would, when put to trial. An unwise purchaser, seeing that one machine looked as well as the other, might readily buy the least economical machine. With respect to the power of agricultural machinery to stand all kinds of work, he remembered what Mr. Greig said at the steam-ploughing trials at Stafford, when it was suggested, upon one of the teeth of the pinion of the anchor breaking, that something had fallen into it. "Fallen into it," said he, "I do not care for any implement that would not take a shower of bolts into it."

Agricultural machinery must be made to stand all kinds of rough-and-tumble work. As regards the paper which had been read, it was hopeless to endeavour to discuss it in anything like a summing-up speech, as it was really like an encyclopædia. It appeared impossible that any man could grasp such a subject in one paper, but as each section came before them, it was impossible to help seeing that Mr. Pidgeon had contrived to touch upon all its leading features. As reference had been made by Mr. Botly to riots on account of machinery, he might remind the meeting of the letters which in olden times had been sent to farmers who used machines. These letters were signed "Swing," and were of a threatening nature, and, in many instances, were followed by the burning of the farmers' stacks. This was, happily, now all changed, and as a proof of the appreciation of machinery, he might mention that in a certain village it was the custom to make the labourers of one farm a present of wheat. These men would never do it by wielding the flail themselves; they always took it to the nearest place where it could be thrashed by machinery. If agriculturists had to compete with bad seasons and foreign importations it could only be done by the aid of machinery. He was sorry to hear Mr. Sherborne give such a gloomy account of his experience of farming for the last 12 years, but if it was no bad for him with machinery, what would it have been without it. With respect to opposition to machinery, it used to be said that agriculturists were behind the age, and would not improve, but they did use machinery. What was the case as far as colliers were concerned? Everyone was aware that coal was got by the laborious and extremely dangerous process called undercutting or hewing. Attempts had been made on many occasions to substitute machine labour for hand labour, and many machines had been tried, the last of which was by Mr. Firth, a coal proprietor of Leeds, who invented a machine which was perfect in its action. This machine was, by the men, first restricted to one pit; but after a time this limitation of its use did not suffice the miners who restricted its use to an hour a day until at last the owner had to give it up in despair. The machine to which he referred, by means of compressed air, swung a pick at the bottom of the coal, making a perfectly level cavity of about three inches deep, and penetrating well into the block. As contrasted with the wedge-formed cavity, some half a yard deep in the front, needed when the work was done by men, this machine economised a large quantity of coal, and prevented its being turned into powder, besides getting rid of a fruitful source of accident; but, nevertheless, the miners, who were upheld as intelligent men, prevented the use of the machine. He was happy to say such was not the case with agriculturists throughout England, for they were always glad to see agricultural engineers coming to the front with some improvement. Mr. Pidgeon had stated that England imported two articles to the amount of 20 millions which she need not import, namely, 12 million pounds worth of butter, and eggs to the value of eight millions. With regard to the first article, he should like to know whether it was all butter, or whether some of it was not a yellow material called butter. When in the United States last autumn, he made it his business to visit one of the large factories where milk from neighbouring farmers was taken in, and turned into butter and cheese, and then sent to the market and sold; and he found that by this wholesale process the labour was very much less, and the benefit to the farmers was exceedingly great. So far as he knew, there was no reason why this system should not be introduced into England. Between October and April he obtained his butter from Milan, and he did so for this reason—that he got better butter than could be obtained in England, and he paid 1d. per lb. less for it. He did not know whether French fowls laid more eggs than English fowls; certainly the ability of France to export eggs did not arise from the limited home use in that country, the fact being that far more use was made of eggs in humble French cookery than in that of the corresponding classes in England. How was it that English farmers could not make this a successful industry. He noticed Mr. Pidgeon stated that, in the olden days, English fowls lived upon the waste product from the flail, and as, owing to the introduction of the thrashing machine, this waste product no longer existed, he suggested it had not occurred to the English farmers that as fowls must live upon something, it was necessary to feed them. In conclusion, he begged to propose a hearty vote of thanks to Mr. Pidgeon for his valuable paper.

Mr. PIDGEON, in reply, said, as reference had been made to free trade by America, he might say that his own opinion was that there was as great an amount of waste production in America as in any other part of the world. Americans were prodigal with material, but economical of labour, and now they could afford to be prodigal; but if they had free trade they would have to be as economical as other nations. He was much obliged to Mr. Nicholson for his correction as to the *locale* of Mr. Wilder. As to the complaint that agricultural implement makers did not sell direct to the farmers, he might point out that this was not the fault of the manufacturers. To his own knowledge, one large firm had tried the experiment of selling direct to the farmers, but it proved an utter failure, their sales dropping off in such a way that had they not resorted to agents, they would have been completely beaten out of the market. All that was wanted was, for the farmers to combine. Until they did this, the middleman would remain master, and, so long as he was master, the makers must sell to agents. He entirely concurred in the remarks of Mr. Botly as to the value of the *Journal of the Royal Agricultural Society*, for he had himself found it a mine of valuable

information upon every subject connected with agriculture. In reply to the Chairman as to whether what they paid twelve millions a year for was butter, he might say that his information upon that subject was obtained from the Secretary of the Aylesbury Dairy. He believed it was buttter, because that gentleman informed him that the British butterman was willing to pay one penny per pound more for butter which came to this country in a marketable condition than for British butter. The British butterman was a discriminating person, and he would not pay a 1d. per pound more for the article unless it was genuine. As to farmers combining for the sale of their produce, he was glad to find that a movement had been started having this object in view.

Miscellaneous.

SILK-PRODUCING BOMBYCES REARED IN 1882.

By Alfred Wailly

(Membre-Lauréat de la Société d'Acclimatation de France).

(Concluded from p. 241.)

North American Species.—Samia Cecropia. Very little success was obtained with this species in 1881, owing to various causes. The number of cocoons obtained was small, the moths seemed weaker than in previous years, and many refused to pair in June, when the weather was wet and cold. From the 21st of May till the 28th inclusive, all the moths were male ones. Owing to these various causes, the number of fertile ova obtained was very small. Some larvæ were reared in the garden, as in previous years, but none reached the spinning period.

Telea Polyphemus.—Moths of this species began to emerge from the 23rd of May, all females up to the 27th. Only three pairings were observed, although I had several dozen moths; four or five dozen I think. As I have already recorded in previous reports, the pairings of this species are generally of very short duration, and often over early in the morning; besides, the moths do not pair easily. If they are disturbed, or the cages even slightly touched, the moths drop instantly down. Hence the difficulty of knowing if the eggs will be good or bad. I had a large quantity of larvæ which hatched from eggs which had been marked as uncertain. On the contrary, ova from some females which had paired did not hatch. All these accidents cause many disappointments and vexations, but every year they may be expected to occur again, unless a very large number of moths can be sacrificed to obtain fertile ova. The larvæ of *Polyphemus* which I reared on small oak trees in my garden, throve remarkably well in spite of bad weather and bad foliage; but the latter failed in September, and the larvæ had to be removed and sent away; the little trees were entirely bare.

Actias Luna.—Of this species I had about four dozen large cocoons, from which I obtained the largest and finest moths I ever had. Yet the success I obtained with respect to the reproduction of the species was worse than with *Telea polyphemus*, owing to one of the causes enumerated before—the emergence of the moths in succession of males or females. There is no reason that I know to account for this, yet it occurs every year; sometimes the males emerge first, sometimes the females. I have taken notes, and marked the dates of the emergence of all the *luna* moths, which commenced on the 10th of May. From that date, to the 13th, all the moths were male; from the 18th to the 27th, inclusive, all were female; after an interval of three days, I had again male moths, up to the 4th of June; then, from the 7th of June to the 19th, all were female; on the 21st a female again emerged, and on the 24th, one male. On the 25th I had a pairing, this was the only one. After that date, all the other moths were female. Therefore, with such a quantity of cocoons, I never had but once a male and female moth emerge so as to have a chance of obtaining a pairing. On the 28th of June, the last female *luna* paired with a male *Selene*, but the ova were not fertile. The way the *luna* moths emerged, from the 10th of May to the 28th of June, is certainly the most extraordinary I ever witnessed. The larvæ from the pairing of the 25th of June hatched on the 16th of July; they were reared in captivity with the greatest success, till a few formed their cocoons in September. I was then unable to attend to them any longer, and sent them to a correspondent to continue the rearing of them, with *Polyphemus* and a few other species.

Of the other American species mentioned, Bombyces and Noctuæ: *Dryocampa regalis*, *Dryocampa stigma*, *Arctia acrea*, *Ceramica picta*, and a *Noctua*, from Georgia, none of the pupæ produced any moths, excepting *Ceramica picta*, larvæ of which hatched from the 4th of June, and were successfully reared on oak branches in captivity.

To conclude, I shall now quote extracts of letters from correspondents in Ceylon and Assam.

"Ceylon, September 9th, 1882.—The attempt to produce mulberry silkworm eggs here, for exportation to Europe, has not been successful. It would do in the hills, perhaps, in situations where the temperature is not more than 75 degrees Fahrenheit; but here (near the coast), the heat in the middle of the day is usually about 82 or 84, and about 90 in Lent, which is the hottest season, and the silkworm does not thrive in so high a temperature for more than one generation. Our silkworms of the first generation, hatched from Japan, throve admirably, and formed their cocoons in twenty-three days. I thought that, owing to the short life of the silk-

worm, there would be less liability to disease than in colder climates; but, in the second generation, many of the silkworms died before making cocoons, and most of the cocoons we did get produced cripple moths; and, in the third generation, not more than two or three per cent. of the silkworms lived to form cocoons. Father Palla, the Catholic missionary, who induced the Ceylon Government to import a supply of Japan seed, is yet hopeful about the success of the mulberry silk even in the maritime provinces; but I do not believe it will ever do any good except in the higher and colder parts of the island. The mulberry tree itself does not grow so well here as in the coffee districts, and it is against nature to suppose that an insect would thrive well in a climate not adapted for the growth of the tree it feeds on. Father Palla thought the Japan seed had been bad, and got other seed from Italy and from India, some of which he gave to me, but that proved much worse than what came from Japan. For the artificial rearing of any kind of *Lepidoptera* I think a temperature from 70 to 75 degrees Fah. is better than a higher one."

The following is an extract from a letter I received in answer to my inquiries respecting the Assam wild silkworms:—

"Sibsagor, Assam, 15th July, 1882.—For some ten or twelve years now, or more, I have collected in various ways, for the Indian Museum, but have omitted to study entomology, for several reasons. . . . . The fact is, this is eminently a good corner for general observation, and if I became even partially a specialist, it would be at the expense of other branches. Thus I am an expert at nothing, except perhaps tea, which is my business, and tea pests which I have studied therewith. This being the case, I do not know many of the silkworms by name, scientifically. I have kept the *Erie*, of Assam, or *Attacus Ricini*, and did so to learn all about the same as a matter of business. I found several things that the authorities in the matters below did not know; one was, the effects of the common (or *a* common) fly that laid its eggs, up to five or six, in the worms if they were not protected. I sent worms down in all stages, from a few recent punctures to those having the flies actually ready to emerge from their cases inside the worms. I obtained statistics of the damage, and decided that unless protected it would not pay on a large scale.

"I had a cloth woven from the silk that weighed 5 lbs., and measured about 20 ft. × 5 ft., drab-grey colour.

"Since then (1868 or 1869), I have not specially attended to these matters except once, when I tried in vain to hatch out a batch of young *Atlas*. There are wild *Moogas* here, small, and that weave a glittery yellow gold net cocoon, but they are, I fancy, only either pests or curios. [This is very likely *Cricula trifenestrata*, mentioned in my report.—A. W.]

"If I can get any of the silk-producing cocoons I will send some, but I fear their hatching out. Perhaps the best time is towards the close of the warm season, in which case they would be hatched in the spring and go safely. . . . . Insects from the hill ranges north, are more likely to succeed with you, as there the climate is temperate, and the flora ditto. . . . . It is a pity illustrations are not more resorted to in all works treating of these matters, autotype or some cheap kind, as then progress would be much more rapid than it is now, when fully half one's time is lost in the attempt to identify, and often ends in mistakes. . . . . I found the *Attacus ricini* extremely easily bred, that is, changed by selection, and eliminated the red or amber cocoons in four broods—eight broods coming out in one season of about nine months, here. I heard after that I was wrong to eliminate the reddish cocoons, as the white showed, by their colour, that they were the weakest. I also selected for size. They eat greedily of a tree we call 'keseru,' which gives far stronger silk than other trees, and eagerly sought by natives, who, however, do not plant as they should. The foliage is peculiarly adapted for feeding worms indoors; each leaflet is some three to four feet long, and the whole compound leaf five to six feet. . . . . It is, for several reasons, preferable to the castor-oil leaf. If the *Mooga*, feeding on the 'soom' trees here, only gave as many generations in the season as the *Erie*, I should at once say it was more worthy of attention; as it is, however, it is very profitable to grow it. . . . . What I feel is much needed is a cheap illustrated handbook of the leading kinds of worms and butterflies, for purposes of recognition, the trees they feed upon, and the local names of the latter; surely such a thing is possible. There are, undoubtedly, many kinds of wild silkworms out here in Assam, I should say as many or more than in most countries. . . . . I will keep the matter in hand; cocoons at end of year; useless to send now with thermometer at 85° to 90°, or more."

I have now left Clapham for Norbiton, Surrey, and I hope to receive communications respecting silk producing and other *Lepidoptera* at the address given below. I shall also suggest a new plan for sending cocoons from distant countries, especially when they are sent late in the season. Each case to be about 12 to 18 inches high, or more, and to be perforated with a number of holes at the four vertical sides, so as to give free ventilation. In the centre of the case, lengthwise and horizontally, to fasten a strong cord from one to the opposite side. The cocoons strung together in batches of six to twelve, according to size, should then be strongly tied all along the cord in the centre of the case. In this way the moths, if emerging during the voyage, would have room to expand their wings, and would, in all probability, pair and lay their eggs on the cocoons and on the sides of the box, so that all would thus be saved.

ALFRED WAILLY.

Tudor-villa, Tudor-road, Norbiton, Surrey.

COAL-FIELDS OF NEW ZEALAND.

Consul Griffin, writing on the trade and industry of New Zealand, mentions that the constantly increasing demand for coal in California, and the existence of a coal famine in Victoria and South Australia, have had the effect of attracting considerable attention to the condition of the coal-fields in the colony of New Zealand; and says that few of its inhabitants have any idea of the vast stores of wealth that are bound up in it. A few years ago, there was but one point in the whole of the vast territory of the Pacific which had begun a competition with the American and English coal trade: this point was New Castle, in the colony of New South Wales. The coal-fields there are of no mean proportion. They extend fully 700 miles north of New Castle, and the annual average output is estimated at about 1,550,000 tons. The seams vary from three to thirty feet in thickness, and the quality of the coal is regarded as the best in the world. Fully one-fourth of the products of the mines is consumed in the colony of Victoria, and it appears, from the last annual report of the Department of Mines of New South Wales, that the people of that colony begin to fear a strong competition from New Zealand. In the latter colony, coal is found in large quantities in the basins of Waikato and Mokan, and also on the tributaries of the Whanganui, and is a species of brown coal belonging to the tertiary age. The seams are covered with bituminous shales and sandstone, and in many respects are similar to those often met with in the centre of Europe, especially within the range of the brown coal deposits of Germany and Austria. The topmost layers generally consist of tabular limestones often protruding at the top of cliffs. In the South Island of New Zealand, deposits of brown coal are found near the Malvern-hills, a distance of about 30 miles from Christchurch, and vast areas of it underlie the tertiary rocks of the higher portions of the great Canterbury plains. In Otago, there are deposits near the Molyneux River, extending at least fifty miles, and forming hills from 500 to 1,000 feet in height. In this formation there are several seams of good coal, varying from six to twenty feet in thickness; and along the seashore, one section of this coal, fully three miles in length and fifty-six feet thick, is exposed to view. It is estimated that this district alone contains over 100,000,000 tons of accessible coal. Several mines have been opened, and one in particular, the "Clutha," has been successfully worked. Within six miles of Dunedin is another important basin, called the Green Island and Saddle Hill. Two of the seams there have been opened, from seven to nine feet thick, and successfully worked. In the vicinity of Green Island, there is an area of ten square miles, containing a seam eighteen feet thick, capable of yielding over 100,000,000 of tons. Owing to the soft nature of the roof and floor, it has been the practice to work only six feet out of the centre of the seam, about two-thirds of the coal being left and wasted. This is occasioned by the scarcity and high price of timber in Otago suitable for propping the mines. There is another great area of brown coal on the western seaboard of Otago, east of the Kakanni mountains, and at Kartangata there is an important field of forty square miles; and in addition to these there are many large deposits of brown coal which have not yet been worked. The black coal-fields of New Zealand are also very extensive; they are found in both the North and South Islands, and occupy large areas in the provinces of Auckland, Nelson, Canterbury, and Otago. A large seam has lately been opened about seventy miles north of Auckland, in the vicinity of the harbour of Wangarei, and another seam on the Kawakawa River. It is stated that the annual output of the Kawakawa mines far exceeds that of any other colliery in New Zealand. About twenty-five miles distant from Kawakawa mines, coal is furnished of a good quality at the Kamo colliery, and many are of opinion that the Kamo workings are only the southern outcrop of the seam of Kawakawa, and that other and still more valuable seams lie underneath. The New Zealand Government has recently constructed a railway from the Kamo mines to the river emptying into the Wangarei harbour. The seams worked at present are eleven feet in thickness, and extend over a vast area; and Consul Griffin says that this colliery is attracting more attention than any other in New Zealand. The coal mines in the South Island greatly outnumber those in the North Island, but many of the former are on a very small scale. The most important of the South Island mines are on the Grey and Butler Rivers; the seams are very thick, and are capable of producing many hundred millions of tons of good coal. These mines, however, are only, as yet, in their infancy. It appears, from returns which have lately been published, that the total product of all the mines of New Zealand for the year ended December 31st, 1880, was 299,923 tons, against 231,218 tons for 1879. Partial returns for the year 1881 indicate that the increase will be in a still greater ratio.

CULTIVATION OF CHINA GRASS.

During the year 1882, a development took place of the interest attaching to the cultivation and use, in manufactures, of China grass, and, with respect to the supply of the raw material, it has been estimated that the progress achieved in 1882 was as much as had been done in that direction during the whole of the fifteen years immediately preceding.

According to a detailed statement, published by the *Central Blatt für Textil-Industrie*, the principal feature of the year was the extension of cultivation in Europe, the bulk of the supply having been received, previously to 1882, from China and the adjacent islands.

China grass has recently acquired a position of con-

siderably augmented importance as an industrial product. This sudden advance of a textile substance, in the estimation of the manufacturing public, is not without precedent. Flax and cotton had, it is remarked, a long period of quiet utilisation before they became such important articles as they now are. The discoveries which gave an unexpected impetus to their employment for industrial purposes were, it is stated, Witney's machine for treating cotton in the raw state, and the flax-spinning machine of Philippe de Girard. In the same way China grass owes its present greatly increased favour to the Favier system of treating the fibre; the introduction of this process having been, in fact, a turning point in its industrial history.

In Italy, M. D'Humières has been for several years making experiments in its culture, and he has recently published the fact that, with suitable arrangements, a profit of 33 per cent. may be made by the grower. Large plantations have now been organised in that country. Portugal has already planted a million roots; and Spain has also taken important steps in the matter. The plantations in Algiers and Egypt have, it would seem, been materially increased. In Java, companies have been formed to promote the culture; and it is stated that in various French colonies, as well as in America, steps will shortly be taken to introduce it. France seems, however, to have taken the lead in the new movement, and, during 1882, several million roots were imported for planting. In the southern departments, fields of China grass are constantly becoming more frequent. Favier's patent is owned, it is stated, by a company entitled, La Ramie Française, which is located at Avignon, and has established nurseries in the departments of Vaucluse, Var, Bonches-du-Rhone, Gard, &c., occupying about seventy-five acres. This company intends to sell plants to the agriculturists, and to arrange for the purchase of the yield. It will also carry on, for its own account, the preparation of the fibre, and will be, therefore, able to offer it to the spinners ready for them to operate upon it.

The spinning of China grass is being developed upon a scale proportionate to its extended cultivation. Before the year 1880, it is stated that there were only two establishments in Europe where China grass was spun, and it would seem that these could only obtain their supplies from the London market. It is remarked that the establishments referred to have, since then, materially extended the scope of their operations. Six others are said to be now in working order, and, doubtless, others are in contemplation.

In France, many trials have been made as to the employment of China grass in various branches of textile manufacture, and from the successful results, it would seem that an important consumption of the article is assured. Its introduction in the trimming, hosiery, and cloth branches, has been well received. Some further modifications in the spinning of the yarn and a lower range of prices would, it is said, place China grass in a prominent position as a textile material. The Ramie Française Company exhibited last year (at the Avignon Industrial Exhibition, and at the Colonial Exhibition, at the Palais d'Industrie in Paris) specimens of dress goods, cloths, and other materials, either entirely made of China grass, or into which it entered as a component part.

It is remarked, in conclusion, that the cause of the leading position held by cotton is the low price of articles made from it. A serious competition is not to be looked for, it is considered, on the part of flax, but it is suggested that China grass, if its price is reduced, may be found for certain purposes an important rival of cotton.

Correspondence.

OVERLAND COMMUNICATION BETWEEN INDIA AND CHINA, VIA ASSAM.

The following communication has been received from Mr. Lepper, as a further answer to Mr. Cassels' question in the discussion on his paper (see *ante* p. 315):—

There is no published grammar, as far as I can find, of the Singpho language, and very little is known of their inner life, manners, customs, prejudices or religion. As my dealings will be almost entirely with Singphos, and further, as it is necessary, so far as is possible, to avoid personal risk and chance of failure, that anyone purposing to live amongst them, with the intention of acquiring their good-will and real influence amongst them, should be thoroughly acquainted with their language, manners, customs, prejudices, &c., I propose acquiring all these by a residence at or near Makum, before attempting any serious work amongst them. The time I shall occupy in thus preparing myself I estimate at two years, as my work is in quite unprepared ground, and I shall not have the assistance of a grammar or even dictionary. It is true my past experience will assist me very much; but I hardly like, under all the circumstances, to estimate for less than a two years' preparation. During that time I shall not only occupy myself in acquiring their language, preparing a vocabulary, &c., but shall use my best efforts to ingratiate myself personally still further into the good-will of our neighbouring Singphos than I have already succeeded in doing. I shall also, during the cold seasons—as it is impossible to live in camp in that climate during the rains—make short trips amongst the neighbouring Singphos, and advance my base-lines as far as I can, so that, when I commence survey-work in earnest, I shall have saved time.

Once I feel satisfied that I have sufficiently prepared myself as above, I propose each cold season

advancing as far as I am asked to go, and then settle at that point for the rest of the cold season, with the object of familiarising the distant Singphos with my presence amongst them, and obtaining thus invitations from the more distant Singphos ahead of me, to go amongst them the following cold season. I have a fair acquaintance with simple medical treatment, and by this means I hope to assist my work of winning their personal attachment. The Singphos have an etiquette which makes them hospitable and courteous to invited guests, and which makes them suspicious and inhospitable to uninvited strangers. This explains my reason for desiring to receive invitations as above. Thus, year by year, every cold season, I hope to gain ground amongst them, till I shall have acquired a personal influence amongst them all, which may lead to great ends. I wish to gain a personal influence which, in the end, shall allow me to wander at will over the "Neutral Ground" between us and China, and not only survey myself, but eventually accompany a fully found survey party. I ask for no escort or guard, as I am convinced that the method I propose will prove the safest and most practical in the long run. I have been asked for schoolmasters by the Singphos. Acting on this, I have a *locus standi* at once. I can tell them that, no European knowing their langaage, a schoolmaster at present would be useless. I go amongst them to learn their language, and render it possible for schoolmasters to learn it from my books. Next it gives me the privilege of surveying and mapping my routes, as I have the excuse of their own making, viz., their desire to learn geography, which would be impossible without maps. They already marvel at our maps, and are eager to learn how to use them. This is a great point, as it allows me to use a plane-table and instruments without creating suspicions of annexation, or foul play, which the sight of instruments so often arouses in the East.

Having acquired a firm personal influence right through the neutral ground to that part of it already visited by Chinese traders, I propose inducing some Chinese to return with me to Makum, there to show them a market in which to supply themselves with European goods, to show them the railway, and the steamers at Dibrugarh, and, if deemed advisable at the time, even to take them to Calcutta, to still further impress them. I propose returning again with this first batch of Chinese, to ensure their safety back to where I found them. I might repeat this more than once, as (the route being now overgrown with jungle, which is a barrier of peculiar terror to Chinese, unaccustomed as they are to jungle life) they will be timid at first.

I hope, however, by my influence, to find no great difficulty in persuading the Singphos (who are intelligent and enterprising enough where their advantage is concerned), to permit our clearing the road of jungle and its attendant terrors, as soon as I have satisfied myself as to the best direction it should take. The head of the railway company in India assures me the company would willingly extend the railway as soon as this route is practically opened, as we know, from several accounts published by previous explorers, that there are no physical difficulties between Makum and the Irrawaddi itself. By far the most difficult part of the route into China lies beyond the Irrawaddi, between Momein and Ta-li-fu, and has now to be passed by the Chinese who already trade on our side of the Irrawaddi. With that part we have nothing to do, as it lies across the Chinese frontier, and we must leave them to improve it, or not, as they may choose.

I propose to deal solely with the neutral ground, and aim at having no dealings with Chinese or Burmese officials, as I have no intention of crossing either of those frontiers; hence, I hope to avoid all political complications, and any necessity for trade or other treaties with those powers.

Commercially, my object is to show the Chinese how near they are to us, and, by increasing facilities of communication between us and the Irrawaddi, render it possible for them to come to us, without any necessity for our going to them.

Geographically, we have the interesting problem of the source of the Irrawaddi, the actual proving by exploration that it has no connection with the Sanpo, and many other questions of great interest at present to geographers, anthropologists, entomologists, philologists, &c., &c., which I need not enlarge upon here.

Politically, we have much to gain by winning over the Singphos to lean on us. The political question is a large one, and can hardly be done justice to in this letter.

C. H. Lepper.

Notes on Books.

Report of the Smoke Abatement Committee, 1882: with Reports of the Jurors of the Exhibition at South Kensington, and Reports of the Testing Engineer; to which are added the Official Reports on the Manchester Exhibition. London: Smith, Elder and Co. 1883. 4to.

When the Exhibition at South Kensington was closed, the collection was transferred to Manchester, where it was again exhibited. At both places an elaborate system of testings was undertaken. In London 290 tests were made altogether, "many of them of a detailed and costly character." This number was made up of 130 tests of grates and stoves, 27 tests of coal-burning kitcheners, 32 tests of gas-heating apparatus, 20 tests of gas-cooking stoves, 4 tests of the Dowson gas producer and applications of the gas, 4 tests of heating apparatus, 27 tests of steam-boiler appliances, 1 test of a gas-engine, and 45 tests of fuels. The results of these testings are given in this volume, and a large number

of plates are added, which contain representations of the objects exhibited. The list of awards is given in the Report, and the details respecting these awards will be found in the Reports of the Jurors. The Society of Arts' medal was awarded to "G. B. Gregory, of Beverley, New Jersey, U.S.A., for his smoke-burning furnace, and for its various applications to steam-boilers and other industrial and domestic purposes."

TRANSIT TABLES FOR 1883: Giving the Greenwich Mean Time of the Sun, and of Certain Stars, for every Day in the Year, with an Ephemeris of the Sun, Moon, and Planets, and other information. Computed from the Nautical Almanac for popular use, by Latimer Clark. London: A. J. Frost. 1883.

This is the first of an annual series of tables which Mr. Clark proposes to publish as companions to the "Treatise on the Transit Instrument," published last year, and noticed in the *Journal* (October 27, p. 1063). Besides the ordinary "Additional Stars," a few high southern stars are included in the catalogue for the use of persons in the southern hemisphere.

CHEMICAL PER-CENTAGE TABLES AND LABORATORY CALCULATION. By A. H. Ridsdale. London: Crosby Lockwood and Co. 1882.

The object of these tables is to save a large proportion of the calculations of the laboratory, and the author states his design in their production to be two-fold (1) to enable the student of chemistry to understand the calculations; and (2) to save the chemists from the greater part of the useless figuring at present necessary.

General Notes.

EPPING FOREST.—At the meeting of the Essex Field Club, held on January 27, the following resolution, condemning the proposed extension of the Great Eastern Railway from Chingford to High Beach, was passed:—"That this society, on behalf of the large section of the population of London interested in the pursuit of natural history, desires to record an emphatic protest against the proposal of the Great Eastern Railway Company to carry a line across a part of Epping Forest, believing that it is wholly unnecessary for the railway to take the route projected, and that it would not fail to prejudicially affect the advantages secured by the Epping Forest Act, which directs that the forest is to be preserved, as far as possible, in its natural aspect, and the society hereby authorises the council to petition Parliament against the project, and to send copies of this resolution to the Press."

INTERNATIONAL ELECTRICAL EXHIBITION, VIENNA.—An International Electrical Exhibition will be held at Vienna, under the patronage of the Austro-Hungarian Government, in the months of August, September, and October next. At the request of the Austrian Minister of Commerce, and of the Managing Committee of the Exhibition, the Council of the Society of Telegraph Engineers and of Electricians have appointed a committee for the purpose of receiving applications for space from intending British exhibitors, and for promoting generally the formation of a British section. Application should be made as early as possible, and should be addressed to the Secretary of the Society of Telegraph Engineers and of Electricians, 4, The Sanctuary, Westminster, S.W.

FRENCH AGRICULTURAL SHOWS.—The following are the localities and dates fixed for the Concours Régionnaux, under the auspices of the French Government, for the present year:—Amiens, Bourg, and Foix, from 5th to 14th May; entries close 31st March. Sidi-Bel-Abbès, Algeria, from 7th to 16th April. Vannes, from 12th to 20th May; entries close 4th April. Digne, and Troyes, from 19th to 27th May; entries close 9th April. Blois and Rochefort, from 26th May to 3rd June; entries close 15th April. Caen, from 9th to 17th June; entries close 19th April. Aurillac, from 16th to 24th June; entries close 19th April. Mende, from 1st to 9th September; entries close 25th July. Nice, from 17th to 25th November.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

FEBRUARY 28.—"The Increasing Destruction of Life and Property by Fire. What is the Remedy?" By CORNELIUS WALFORD.

MARCH 7.—"The History of the Pianoforte." By A. J. HIPKINS. JOHN STAINER, M.A., Mus. Doc., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at 8 o'clock:—

FEBRUARY 27.—"Egypt, Present and to Come." By ROBERT W. FELKIN.

MARCH 20.—"Social and Commercial Aspects of New Zealand." By WILLIAM DELISLE HAY.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings at Eight o'clock:—

MARCH 8.—"Self-purification of River Waters." By W. N. HARTLEY, F.R.S.E.

APRIL 12.—"The Formation of Diastase from Grain by Moulds." By R. W. ATKINSON, B.Sc.

INDIAN SECTION.

Friday evenings at Eight o'clock :—

MARCH 2.—"Agriculture in Lower Bengal: with some Notice of Tenant Right, &c." By W. S. SETON-KARR. The Honourable Sir ASHLEY EDEN, K.C.S.I., will preside.

APRIL 6.—"Private Enterprise in India." By J. M. MACLEAN.

APRIL 20.—"Fisheries of India." By Surgeon-General FRANCIS DAY.

MAY 4.—"Some Notes on the Domestic Architecture of India." By C. PURDON CLARKE.

MAY 25.—

CANTOR LECTURES.

Monday evenings at Eight o'clock :—

Second Course, on "Solid and Liquid Illuminating Agents." By LEOPOLD FIELD.

LECTURE V.—FEBRUARY 26.

Paraffin. History and sources. Outlines of the chief processes of manufacture. Coal-tar products. Paraffin oil. Naphtha. Petroleum.

LECTURE VI.—MARCH 5.

Ozokerit, and other mineral sources of light. Manufacture of Candles. Survey of the candle trade and the various inventions and industries excited hereby. Conclusion.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Leopold Field, "Solid and Liquid Illuminating Agents." (Lecture V.)

Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. A. T. Walmsley, "Land Surveying and Levelling." (Lecture VII.)

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Robert Blake White, "The Central Provinces of Colombia (New Granada").

Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. 1. Mr. W. Sutton, "The Method used by Milne in the Construction of the Carlisle Bill of Mortality." 2. Mr. J. A. Higham, "The Adjustment of Mortality Tables."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. G. Romanes, "Starfish."

TUESDAY, FEB. 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. Robert W. Felkin, "Egypt, Present and to Come."

Royal Institution, Albemarle-street, W., 3 p.m. Professor R. S. Ball, "The Supreme Discoveries n Astronomy." (Lecture II.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on Mr. William Morris's Paper, "Covered Service-Reservoirs."

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. Mr. Alfred Tylor, "The Homological Nature of the Human Skeleton."

WEDNESDAY, FEB. 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Cornelius Walford, "The Increasing Destruction of Life and Property by Fire. What is the Remedy?"

Royal College of Physicians, Pall-mall East, S.W., 5 p.m. Dr. J. E. Pollock, "Modern Theories and Treatment of Phthisis." (Lecture I.)

Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

THURSDAY, MARCH 1...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Alfred W. Bennett, "The Constancy of Insects in their Visits to Flowers." 2. Mr. G. J. Romanes, "Observations on Living Echinoderms." 3. Mr. R. Miller Christy, "Methodic Habits of Insects when Frequenting Flowers." 4. Mr. R. Boog Watson, "Mollusca of *Challenger* Expedition."

Social Science Association (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m. Conference on the Bringing up and Education of Pauper Children.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Special Meeting. Sir Frederick Bramwell, "Telephones."

Chemical, Burlington-house, W., 8 p.m. Ballot for election of Fellows. Professors H. E. Armstrong and E. H. Rennie, "Some Derivatives of the Isomeric $C_{10}H_{14}O$ Phenols."

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. W. A. Barrett, "William Michael Balfe."

South London Photographic (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Mr. T. Bolas, "Some Arrangement for Using the Electric Light for the Developing Room." With Illustrations.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Spectroscope and its Applications." (Lecture VII.)

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. R. Nelson Boyd, "The Importation and Distribution of Foreign Iron Ore."

Archæological Institution, 16, New Burlington-street, W., 4 p.m.

FRIDAY, MARCH 2...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. W. S. Seton-Karr, "Agriculture in Lower Bengal: With Some Notice of Tenant Right, &c."

Social Science Association, (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m. Conference on the Bringing up and Education of Pauper Children.

Royal United Service Institution, Whitehall-yard, 3 p.m. Lieut.-Col. C. E. Webber, "Suggestions as to the Transport of the Future."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m.

Royal College of Physicians, Pall-mall East, S.W., 5 p.m. Dr. J. E. Pollock, "Modern Theories and Treatment of Phthisis." (Lecture II.)

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m.

SATURDAY, MARCH 3...Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. H. Stone, "Singing, Speaking, and Stammering." (Lecture III.)

Journal of the Society of Arts.

No. 1,580. Vol. XXXI.

FRIDAY, MARCH 2, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The fifth lecture of the course on "Solid and Liquid Illuminating Agents," was delivered by Mr. Leopold Field, F.C.S., on Monday evening, February 26th. The lecture was devoted to the consideration of the history and sources of paraffin, the coal-tar products, paraffin oil, naphtha, and petroleum.

The lectures will be printed in the *Journal* during the summer recess.

SOCIETY OF ARTS' PATENT BILL.

The Society's Patent Bill, introduced by Sir John Lubbock, was read a second time in the House of Commons on Tuesday, 27th February, as was also a Bill (Patents for Inventions, No. 3) introduced by Mr. Anderson. The second reading of the Government Patent Bill, fixed for Monday, February 26th, has been deferred until Thursday, 8th March.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, February 27th; Hyde Clarke in the chair.

The paper read was—

EGYPT, PRESENT AND TO COME.

By Robert W. Felkin, F.R.G.S.

There are two very great temptations which I find in writing upon the subject of Egypt. The one is to occupy too much time on its interesting history—and the other, to enter the field of politics. It will be my endeavour to resist both these allurements. I must, however, just touch on the history of Egypt, in order to make clear its present condition; but I will do so in as few words as possible, and trust it will not be considered that I am overstepping the limit which is imposed upon upon me, both by time and expediency.

Numerous pictures, found in the tombs built about 3,000 years B.C., furnish very strong evidence, by the colour and type of the people there depicted, that they were of Asiatic origin, and probably migrated from Asia over the Isthmus of Suez. The configuration of their skulls also seems to prove this, even if their language causes us any doubt as to their origin. It may be difficult to fix, even approximately, the date of their entrance into Egypt, and to know certainly who were the original inhabitants of the country; but we may conclude that the culture and civilisation of Egypt came from Asia, and not from Ethiopia, as has been suggested by one authority.

Interesting as it would be, it is not my intention, on this occasion, to discuss the problem as to when the Egyptian nation became great and powerful, or to enter into the vexed question of the formation of the Nile Delta. Two facts, at least, will be admitted—that the Nile Delta does exist, and that the Egyptians were once highly civilised, learned and powerful, living under beneficent laws, and possessing great wealth.

Near Spreos Artemidos, on the east bank of the Nile, the sculptures of Beni Hassan represent ancient Egyptians as skilled in the manufacture of glass, linen, gold ornaments, and cabinet work. They played draughts and games of ball as amusements, and cultivated gymnastic exercises to improve their physical development. They fenced with single sticks, and, curious as it may seem, pictures painted thousands of years ago represent feats of strength even now looked upon with admiration in the modern circus, the chief difference being that women seem then to have been the performers. We must notice some geographical facts which influenced the country throughout its history, and still play an important part in its political economy.

Egypt is bounded by deserts and seas, and so confined to a well-defined area. The Nile, with its yearly inundations, has been for centuries, and still remains, the main source of wealth to the country, and the strong magnet which has held the people together. Only in very recent

times has there been any large extension of area.

Notwithstanding many invasions and many foreign occupations, the native Egyptians have for centuries been unchanged by foreign influences. An example will show what I mean. About 2100 B.C., the Hyksos overran Egypt, built forts, and remained conquerors for about 500 years, but no intermixture of race occurred. Continued hate between conquerors and conquered obtained, and certainly no intermarriages took place. The old customs, religion, and laws remained intact. According to Herodotus, and modern historians seem to uphold the statement, twelve kings ruled over twelve provinces in Egypt about the time of Sennacherib; and, nothwithstanding many subsequent changes under later rulers, these old territorial divisions were kept up until the reign of the Mamlooks. Again, the Jews have left no trace of their residence in the country; and when the Egyptains conquered Nubia, &c., the people introduced into the land from those countries were treated as slaves, and no admixture of blood was permitted.

It would be wearisome to follow the history of the different rulers who successively gained aseendancy in Egypt; but it remains on record that, after each period of oppression, the Egyptians speedily regained their power and wealth. About 700 A.D., the Mahommedan religion was introduced into Egypt, and accepted by the inhabitants. From that time its rulers were independent Mahommedan princes, until, in 1517 A.D., they became subject to Turkey, whose rule has, with some vicissitudes, continued till the present time; although of late years it has been almost a nominal one.

The population of Egypt Proper, that is of the Nile Delta, and the land south of it, as far as Wadi Halfa, is given by Behm and Wagner at 5,583,000, which is, probably, exact enough for all practical purposes. This population is composed of numerous elements. We may class them, with some approach to truth, as follows:—

Egyptians Proper	5,000,000
Copts	290,000
Jews and Armenians.....	12,000
Negroes and Abyssinians.....	40,000
French.....	16,500
Germans and Austrians	7,000
British Subjects.....	6,000
Italians	14,000
Syrians, Greeks, and other Levantines	50,000
Other Foreigners	2,000
Bedaween	95,000

The population of Cairo is about 350,000, of Alexandria 213,000. There are no other towns of any considerable size. These figures are based on reports up to the beginning of 1882, but will not be correct now as to foreigners.

In order to understand the present state of Egypt, we must rapidly glance at the characteristics of some of the different races, and see how they are occupied, and in what way they influence the country. Leaving for the present the Egyptians proper, we take first the Copts under review. They were very numerous, and form a very important selection of the community, being more enlightened and better educated than the Egyptians, and frequently employed in Government service as bookkeepers and scribes, and in all similar offices. Were opportunity given, most of them would become good mechanics and merchants, for even now they conduct trade as weavers, smiths, and tailors.

The Turks and Circassians we may next class together, as the Egyptians themselves do. They chiefly occupy positions as Government officials or officers in the army, or they live at their ease, being supported by their numerous slaves. They are overbearing, and greatly oppress the Fellaheen, and the sooner they are expelled the better for Egypt.

Most of the Jews and Armenians are traders, or bankers and money changers; and though despised by the more highly-educated Moslem, they are a decided power in the land.

Nearly all the negroes and Abyssinians are slaves, employed in the harems or as domestic servants. Their absence would be greatly felt by their masters, and by European residents, who value them very highly as servants. If emancipated, they would be of far more use than at present, for now their one object in life is to eat, drink, and sleep as much as possible. Constant change of masters does not induce them to work hard, and they have little or no money to save, for those who are let out on hire to European employers are compelled to give their wages to their masters.

Of the Europeans I need say little, except to mention the fact that many of the most thorough scamps of Europe are to be found in Alexandria, Cairo, Suez, and Port Said. Much greater vigilance should be exercised,

both by the Egyptian Government and by the foreign consuls, to prevent the abominations committed by them.

Greeks have penetrated the interior as far as Khartoum, Fashoda, Lado, Dem Zibehr, Darfour, and Khordofan, introducing ardent spirits, and teaching the natives vices of which they of themselves would be utterly incapable. I know that in all countries there will be a vagabond population, but in Egypt, the vilest of the vile have settled like vultures on their prey. The Bedaween only require mention on account of their unsettled habits and love of plunder, which, indeed, constitute the only necessity for an army in Egypt proper. They are of use to the State in the breeding of camels, horses, and, to a less extent, of cattle.

We now come to consider the Fellaheen, the most important of all the nationalities, being by far the most numerous, and, at the same time, the rightful owners of the land, and the people who do the work and pay the taxes. The Fellaheen live in a very simple manner, and their wants are easily supplied. A Fellah's clothes consist of a long blue shirt, over this a home-spun goats'-hair mantle, and a felt cap, but he is accustomed to work all day quite naked, and hardly ever wears shoes. His food consists, principally, of common dhurra cakes, sour milk, and a large quantity of water melons when in season. He rarely eats meat, except, perhaps, on the three great feast days. The houses of the Fellaheen are miserable, dirty huts; four walls built of Nile mud, are covered by a roof of dhurra stalks; there is a low door, but rarely any window. The furniture consists of a few mats and a bed, which also serves for a table. The Fellaheen take no interest in politics, or as to who rules them, or to whom they have to pay their taxes. They think only of their day's work, and care not what changes take place, knowing that, whoever rules, the taxes will have to be paid. Still, however, in justice to the Fellaheen, be it said that, notwithstanding this indifference, they are intelligent, and though down-trodden and convinced of the impossibility of throwing off their oppressor's yoke, they, nevertheless, possess so large an amount of native dignity as to show they are capable of better things. It would be a great mistake to suppose that the Fellaheen are not hard-worked. They have to work very hard from before sunrise to long after sunset, and most of their work is in mud and water.

Farming operations are carried on in a simple manner. Most of the ground is sown without being previously ploughed, the seeds being pressed into the muddy land either by rough wooden rollers, drawn by oxen, or in a still simpler manner by driving a herd of cattle over it. Any ground that really needs ploughing, is tilled by the exact kind of plough used 5,000 years ago. The furrows made by these ploughs are very shallow, and are further broken up by a kind of wooden cudgel. The spade, however, is the usual agricultural implement, and the people are very skilful in its use, especially for making dams, canals, &c. Reaping is either accomplished by the sickle, or the people simply pull up the stalks by the roots. The harvest is carried home upon asses, camels, and horses, the use of waggons not being possible, on account of the numerous canals and dams.

Rain is very uncommon in Egypt, therefore all the cultivated land has to be irrigated artificially from the Nile, the rise of which is, consequently, all-important to the country. The height of the Nile is carefully measured at Cairo, and intimated to the people, in order that they may know how much land to cultivate. The rise of the Nile begins at Asouan about the end of Jnne, at Cairo the beginning of July, and it continues to rise slowly until the middle of August, by which time the river has generally attained half its maximum height. In Cairo, the highest point is usually reached between the 20th and 30th of September, full flood remaining for about 14 days. By the middle of November the water has receded to half flood, sinking gradually until the end of May, when it is at its lowest level. These dates are only relatively correct. During the last 30 years, the earliest maximum was reached on August 27th, 1868, and the latest on October 20th, 1872. It must not be imagined that the Nile literally floods the land, for its banks are dammed up, and the water is distributed over the land by a perfect network of canals throughout Upper and Lower Egypt.

In 1877, the total length of the canals was 13,440 kilometres; of these canals, 113 were large enough for boats, and there were 348 small canals between Asouan and Cairo, and 408 in Lower Egypt. The mud which is deposited in them would soon fill them up, but in Lower Egypt 150,000 men are employed for four months, during low Nile, in cleaning them out. The number of men thus employed in Upper Egypt I am unable to give.

In order to irrigate the land lying at a higher level than the canals, five years ago, there were 30,084 sakiehs, 70,058 shadoofs, 6,926 tabuts, and 476 steam-pumps employed,

working 180 days a year. Those farmers who do not possess sakiehs must employ the shadoofs, and must work the whole day and part of the night (and the labour is very severe); therefore the lot of such is far worse than than that of the poorest European farm-servant.

The Delta land is so impregnated with salt that the deposit of Nile mud is absolutely necessary to enable the people to grow crops upon it. They have very little idea of manuring the land, and there is no doubt that, were artificial manures introduced into the country, the crops would be far heavier than at present, and the labour of the people much lightened. A modern agricultural chemist could do much to increase the fertility of the soil; and a school of scientific farming, guided by him, would be of great advantage to the people.

Tax-collecting in Egypt is carried on with great unfairness. Did time permit, I could relate many instances which have come under my own observation of the unjust and brutal manner in which taxes are collected, and of the vast sums which find their way into the tax-collectors' pockets. One fact, however, must be remembered—that it is difficult to find a Copt or a Fellah who will pay his taxes until he has received a sufficient number of blows to satisfy his conscience. For thousands of years the people have been down-trodden and overburdened, and this has certainly not been without a marked effect on their moral character. The Mohammedan religion has bred indolence; and the avarice of the governing classes has developed cunning, lying, and greed, so that now, if a Fellah parted with his money without a proper amount of bastinado, his comrades would consider him a coward, and he would lose all respect from the members of the fair sex. There is a story told by the late Sir G. Wilkinson, which well illustrates this point. "In 1822, a Copt was brought before a judge and ordered to pay his taxes. He refused, saying he had not the wherewithal to pay. He was then threatened with the stick, and still refusing, received a sound beating. He then went home to get the money. His wife asked him what he was going to do with it, and hearing it was to pay taxes, she at once began to chide him for cowardice. When he told her, however, that he had received 100 blows, she was content that he should pay." Episodes like this occur daily, even now, and the people will go on refusing to pay until they are educated to pay in a different manner, and are justly taxed. A slight change for the better has recently taken place in this particular, for the people have, on the whole, been taxed in a more regular manner in Lower Egypt, and this creates hope that, if the taxes be regularly and justly collected, the difficulties in collecting them will diminish rapidly.

One of the great factors in impoverishing the people is the taxing of the sakiehs. When a man can just feed himself and family, and pay his taxes, with one sakieh, why should he put up another, knowing that it will be heavily taxed, and that he would at once be marked out for plunder by the rapacious tax-gatherer? Naturally, he will sooner do less work, and give up any idea of advance in the battle of life.

One of the first lessons that the Fellaheen need to learn is, that justice must not be bought, for at present the man who pays most wins the cause, and an Egyptian witness will swear anything provided he is paid for it. We may consider the Egyptian honest under ordinary circumstances; but as soon as he gets into Government employ, he imagines it to be his right to enrich himself as soon as possible without scruple as to the means employed. Until recently, taxes were raised in the following manner:—The governor of a province delivered to the finance minister the amount of taxes farmed from his domain, which the minister would pay into the treasury, less "backsheesh" for himself, the governor having already deducted his share, which again had been done by the under-governors. The Government never gave receipts to the Fellaheen for taxes they paid, and if anyone had to receive money from the Government, "backsheesh" had always to be paid upon it before it was forthcoming. Justice always went to the highest bidder.

The present debt of Egypt is very great—about £100,000,000. If interest is to be paid on this large sum, and the country, at the same time, to be developed, great financial changes must be made.* For my own part, I think that, considering the Egyptians never received the loans in full, and that they have paid a very high rate of interest on them, some sacrifice ought to be made by the bondholders. One authority proves by Blue-books that 45 millions of this debt at par, *plus* 6 per cent. interest, and £3,752,914 in excess, has already been repaid. If this be so, the Egyptians have paid very dearly for their

* Taking the revenue of Egypt at about 8½ millions; 4½ millions goes to the bondholders, £500,000 to the army, and £700,000 to Turkey.

improvements, and the burden they are compelled to bear should, in justice, be lightened. Be this as it may, a system of just taxation must be introduced, and foreigners as well as natives be made to pay a fair tax, collected without favour and without abuse. It has been a great mistake not to make all resident Europeans pay taxes; many of them amass considerable wealth among the Egyptians, and should, therefore, help to support the country in which they prosper. Other and lower-class Europeans, by escaping taxation, are able to live cheaply, and with little exertion, which explains partly the great attraction Egypt possesses for adventurers from all parts of southern Europe. Tax them, and they will not find life so easy; they will be obliged to work, or to leave the country. The tribute of £700,000 now paid yearly to Turkey is a burden which should be done away with, either by a convention or a lump sum paid down, and a large and costly standing army is perfectly unnecessary.

Before proceeding to consider what steps are best calculated to advance prosperity in Egypt, and to raise its people to a higher level, I wish to make one thing clear; that the whole of this paper is based on my belief that England will not leave Egypt until such time as order, justice, and fair taxation in the country are established, and slavery abolished. It is my conviction that, with an enlightened Government, a small army, and even-handed justice, the people have characteristics which will raise them once again to prosperity and contentment. Useless, and worse than useless inhabitants, such as Turks and Circassians, must be eliminated, and this would soon occur were slavery abolished, for they will not work, and so would wander to find more congenial surroundings. Government monopolies must cease, and free trade be introduced; but this will be difficult, if not impossible in the Soudan, till slavery is abolished in Egypt, and the holding and transfer of slaves made illegal.

Some alteration will have to be made in the Suez Canal at no distant date, to meet the demands for a speedier service. The present Canal must be widened at great cost, and the existing very high tolls be lowered, or a new canal will be required; in which case, looking at the question from a commercial point of view, it would be good policy to construct one from Alexandria, *viâ* Cairo, to Suez, rather than to plan a second near the present canal.

The Suez Canal is of vital importance to European nations; but there can be little doubt that Egypt has suffered very heavily in consequence of its construction. Not only has traffic been diverted from Alexandria, but the concessions made to the company were very great; some of them having been rebought at a cost of nearly four millions sterling, adding another heavy burden to an already over-taxed land.

A canal from Alexandria to Suez would greatly benefit Egypt, by making Alexandria again one of the great ports of the world, increasing the number of visitors to Cairo, and thus adding greatly to the revenue of the country; and, by the proposed building of docks at Cairo, trade would be largely stimulated. That such a canal could be made seems quite clear, and that it would not entail so much labour as the Suez Canal, is probable; the estimated cost being about £12,000,000. The locks which would be required in this undertaking appear to constitute the only point on which a difference of opinion has been expressed. Several eminent engineers, however, see no difficulty in their construction, and do not doubt their success; therefore they need not be considered as a bar in project. In the proposed ship-canal to Manchester locks are to be employed; and, if feasible there, why should they not be so in Egypt?

The traffic must be very considerable in order to keep up such a canal and pay interest on the large outlay; but when once made, it would not be so expensive to maintain as the Suez Canal. Besides, valuable data as to width, depth &c., learnt in the construction of the Suez Canal, would be available in another somewhat similar undertaking, and mistakes made in the former would be avoided in the latter. The present rate of increase in traffic is sufficient to allay all fear that two canals would not pay, and there is no doubt that lower rates would be a great boon to commerce, and would be an important element in its extension. But the new canal would have a further important effect on Egypt, apart from the revenue produced by greater traffic. It would be used to irrigate the land, and the dues paid for water would represent a very important annual sum. This, of course, could only be derived from a fresh water canal. The gain to Egypt would be enormous, for at the present time somewhat more than half the value of all crops raised is spent in irrigation. The proposed canal would render some four millions more feddans of land, now barren,

capable of cultivation (one feddan = $1\frac{1}{60}$ acre.) It is roughly calculated that, at the present time, each acre of land requires the work of two men for over 100 days a year to cultivate it, and in the whole system of irrigation, 135,000 oxen and some 60,000 men find employment.

It will be easily seen that the proposed canal would greatly lighten the cost of irrigation, and also reduce the number of men and oxen employed in it, so that the extra amount of land which the new canal would render possible of cultivation would not be without sufficient men and oxen to farm it. It seems, therefore, clear that such a canal would greatly add to the wealth and well-being of the people, while materially increasing the revenue of the country. Anyway, something must be done to forward cultivation.* The barrage, as it exists, is not a success, and can never be really useful unless an enormous sum be laid out on it, which would hardly be profitable. Even to put it into partial repair, with the extra amount of steam-pumping required to meet the present demands for water, would cost, at the lowest computation, five millions, or nearly half the cost of the new canal.

At first sight, there seems one great objection to the canal, from a shipowner's point of view, for it is calculated that the passage by it would occupy about twenty-four hours longer than by the Suez Canal; that is to say, the voyage from Malta to Aden, *viâ* the Suez Canal, would be twenty-four hours shorter than by the new canal, which would be some 240 miles long. Ships could not steam through it so fast as in the open sea, though, if it were properly made, their progress would be much faster than through the present canal. Besides, the passage through fresh water would scour the bottoms of the ships, in consequence of which, they would be able afterwards to attain a higher rate of speed than is possible now that they are in salt water during the whole of their voyage. The passage from Suez to the ship's destination would be accomplished in from two to three days shorter time, so that, instead of incurring a loss, the alteration of route would result in a decided gain.

Of the advantage to England of a second canal I do not speak, as this would bring me towards the realm of politics, which I do not wish to enter. Two canals across the Isthmus of Suez could never be so useful to England, or so profitable to shareholders, or to Egypt; and therefore I would urge that, instead of spending immense sums on the extension of an undertaking which must after all be a foreign one, we English shall make one for ourselves, and in so doing help to raise a fallen nation, and greatly increase our own and their prosperity.

As regards the commerce of Egypt proper, there seems to be no doubt that agriculture will continue to be of the greatest importance, and that the production of grain and cotton would be enormously increased, if only the people could rely upon a regular supply of water. The amount of cotton and grain exported varies very much; and whereas in 1862, 1,328,850 ardebs of wheat were exported, in 1870 there were only 14,990. It will be seen, by the following Table, how greatly the country would prosper if regularly watered, as now a bad Nile makes a difference to the amount exported of about £5,000,000. The Table gives the amount of wheat exported for 19 years; for 1877 I have, unfortunately, no data.

Wheat Exported in

	Ardebs.		Ardebs.
1862	1,328,850	1872	867,720
1863	779,320	1873	511,360
1864	88,110	1874	429,720
1865	1,200	1875	320,800
1866	12,530	1876	517,470
1867	798,200	1877	
1868	1,147,140	1878	90,000
1869	368,890	1879	1,273,545
1870	14,990	1880	946,965
1871	464,630		

In 1876, the value of imports was, in round numbers, $4\frac{1}{4}$ millions; in 1881, $7\frac{1}{2}$ millions; and it is to be noticed that this was a gradual yearly rise, showing that the country has gradually been increasing in prosperity. Of course, if an increase in the production of grain and cotton were rendered possible by improved and extended irrigation, other industries would be greatly stimulated. Till now, only about 7,000 tons of flour have been exported yearly on an average; but cotton and flour mills could be greatly increased, and other trades, such as cotton-spinning, cotton and silk weaving, carpet manufacturing, and paper making, could easily be developed.

Apart from the improvement which may reasonably be expected in the commercial position of Egypt Proper, we have yet to consider that most important part of the Egyptian dominion where, under good government, and

* Nubar Pasha says that the Delta crops have decreased at least one-third during the last twenty years.

with proper precautions, the greatest advance is likely to be made, and which will eventually exercise a great and lasting effect on the commercial relations of England with Egypt. I refer to the vast equatorial possessions of Egypt, the extent and significance of which do not seem to be fully realised, either by governments or business men.

Egypt, under a settled government, will become the basis of commerce with an enormous population. Leaving out of the question Egypt Proper—which, according to Behm and Wagner's last estimate (1882), contain a population of 5,586,000—there are:—

	Population.
Equatorial regions ruled over by Egypt	10,800,000
And the regions in Central Africa, which trade with Egypt at present, but are under independent rulers (*e.g.*, Wadai, Bornu, &c.).....	31,800,000
Total.....	42,600,000
Also equatorial regions which could trade with Egypt better than with Zanzibar—Uganda and Unyoro	6,500,000

It is alleged that the Soudan does not pay. I wish, first, to show what are the reasons for this want of success; afterwards, I will draw your attention to the various districts of this vast region, and endeavour to show the capabilities they possess for commercial purposes. Because, up to the present, no great trade with the Soudan has been developed, and the taxes apparently have not met the Government expenses, it is said that the Soudan is an incumbrance to Egypt, and that no future success is possible. It will be well, however, to look first to the reasons of this failure before pronouncing it a hopeless case. The causes may briefly be summed up in two words—misrule and corruption.

These large tracts of country were not annexed without immense cost, but annexation was not followed by any effort to rule the land taken possession of with firmness or justice, or to establish any definite form of trade. What could be at once obtained was grasped at, and no thought spent on ultimate profit. This was notably the case in the equatorial regions and Darfour, where the people were robbed of grain and cattle to such a extent that in some parts cattle have disappeared altogether.

Before the annexation of the White Nile districts, trade of some kind did exist, and was increasing yearly; but, at the same time, the slave trade was growing too. The Government attempted to stop the latter by taking all other trade into their own hands. All enterprise was thus checked, and the traders were banished. The reason of the prohibition was the supposition, true enough at the time, that legitimate trade was so intimately connected with the slave trade that the two could not be separated. Now, however, this fear will no longer be entertained, for, in the Equatorial Province, the slave trade has been abolished, and, with due precautions, will never revive—certainly not if slavery is abolished in Egypt, as seems to be probable now. This is so evident to the new Governor-General of the Soudan, and to Dr. Emin Bey, Governor of the Equatorial Province, that they have recently decided to allow open trade to recommence, and only retain the monopoly of the trade in ivory, which now, and for a good many years to come, will pay for the entire government of the whole equatorial region. The trade in ivory will come to an end eventually, but by that time other trades will have so far developed as to replace it for Government purposes; and the extinction of the elephants may be delayed longer than was once feared, pressure having been brought to bear against the reckless manner in which they are destroyed.

The slave trade and system of slavery have, in other ways, largely restricted commercial relations with the Soudan, and still act prejudiclally to the extension of commerce in Egypt, and the development of the resources of its vast territories. We must remember the great number of people engaged in the trade, and that nearly all the working inhabitants of the populous provinces of Darfour and Kordofan are wholly employed in providing food and water for slave caravans. Thus, almost an entire population are prevented from working for the good of the State and for their own advancement. The exports of Kordofan amount to £120,000 annually, and the imports to £50,000, about four-fifths of the latter being for cotton goods. It is estimated that the population is about 250,000, so that the trade is, at present, very small, compared with what it might be if the people were largely engaged in it, instead of being, as above stated, occupied in meeting the wants of the slave trade. This evil exists also in the provinces. Many thousands of persons are occupied in the degrading business of pandering to the lazy and vicious habits of innumerable Turks and Circassians, who themselves not only do nothing for the State, but evade taxes

and prevent their slaves from working profitably and contributing to the revenue of the country.

I am well aware that the abolition of slavery throughout the whole of the Egyptian possessions cannot be carried out by a stroke of the pen, but I consider that abolition can be effected in Egypt Proper, and in the outlying districts, if the holding of slaves were prohibited, and that the cessation of the demand will result in the entire abolition of the trade. Only a few years would be necessary to educate the natives to bear freedom. A paternal government must, it is true, be maintained for many years to come in the Soudan, but that kind of rule is well understood, and in many instances has been carried out with the best results.

There is still more, however, to account for the unsatisfactory aspect of Soudan financial affairs. In the first place, they are not really what they appear on paper. The debt was £350,000 in 1881; but a great part of this was money debited to the Soudan account by officials in Cairo, who wanted to cook their own balance-sheets. A good deal of manipulation was done in the Soudan accounts; indeed, no trustworthy accounts have ever been made up there. For several years the Finance Minister could neither read nor write, and a mistake of a million or two dollars was considered of no consequence. But it is almost certain that even now, were honest officials employed, and a simple common-sense rule introduced, the Soudan would show a good yearly balance on the right side of the ledger. Bribery and corruption so completely permeate all ranks, that it would be hard to find a dozen men in the whole Soudan who would not accept backsheesh. If, however, European governors were appointed, an immediate change would be the result, and even without additional trade, a financial success would be ensured. The good work accomplished by Emin Bey and Gessi Pasha shows what is possible, and a few more such men, and such as Lupton and Slatin, would soon justify their appointment.

It is wonderful how soon a change follows the appointment of a European governor. Order appears out of chaos; the Arabs quickly find honesty to be the best policy, and when they once realize that, and that their ruler is strong and firm, they become respectable beings, and are not so difficult to manage as might be expected, judging from their shameful demeanour when left to follow their own wills.

Single-handed, however, no Governor-General of the Soudan can succeed. He must have a staff of really trustworthy lieutenants, to keep order in the numerous outposts of his vast domain, and to carry out his policy faithfully and unflinchingly. During the short time that Gordon Pasha was Governor-General of the whole Soudan he did succeed in keeping the vast district in order; but, being single-handed, and financially unsupported by the Egyptian Government, it was impossible for him to forward the commercial development of the country.

To understand the Soudan properly, we must divide it into districts, for the inhabitants vary considerably as to race and degree of civilisation. First, then, we can divide it by the 9th parallel of north latitude into two great districts. North of latitude 9°, the population is composed of various Arab and Nubian tribes—all professedly Mohammedans. The districts are governed on a system such as obtains in Egypt proper, with certain modifications required by the tribal hostilities and lower state of civilisation.

This large division may be sub-divided into four districts: — (*a*) One commencing at 21° 00′ 00″ N. lat.; and extending south, to Khartoum, bounded on the east by the Red Sea, and on the west by 28° 00′ 00″ E. long. (The Shillook district, although Negro, must be added to this, as it is under the direct rule of the Mudir of Khartoum.) (*b*) Senaar. (*c*) Kardofan. (*d*) Darfour. It is needless to mention the boundaries of these three provinces, as they are marked on all recent maps. South of lat. 9° 00′ 00″ N. are only Negro tribes, and we must sub-divide this district into three parts. (1) The Bahr-el-Ghazel and Rohl province, bounded on the north by lat. 9°, on the east by the Nile, on the west by 24° E. long., and on the south by 6° N. lat. (2) The Equatorial Province proper; its boundaries are somewhat complicated, but may be roughly stated thus:—On the north it is bounded by 9° N. lat., on the west by the Nile as far as Lado, and then the boundary line must be pushed 100 miles west, and continued in a curve to the south end of the Albert Lake. The southern boundary is the Albert Lake, the Victoria Nile, and a line drawn from Foweira to 34° 20′ 00″ E. long., which same parallel forms the eastern boundary line.

3. A district south of the Bahr-el-Ghazel province, and west of the Equatorial Province; its borders are undefined, but, roughly, are 2° N and 24° E.

Taking this latter district first under review, we find that a rough and ready rule exists there. The people are of numerous tribes, some are cannibals. The chiefs are mostly independent, but knowing the power of Egypt, pay tribute in cattle, grain, ivory, wax, and feathers. The country is very fertile, densely populated, and the inhabitants are well fitted to make rapid progress under proper government.

The Bahr-el-Ghazel province was the scene of the great slave war of 1878-79, and it was from it that many of the people were carried into slavery. When I was there at the end of 1869, order had again been established, the people were rapidly settling down to ordinary occupations, and caoutchouc was being gathered in large quantities. I saw enough to convince me that an extensive trade could soon be established there. Wheat, maize, cotton, rice, and vegetables flourish; the climate is good, and in the southern part, the highlands, 4,000 ft. above sea level, would be eligible for colonisation.

The Equatorial Province proper next comes under view, and of it a far different picture must be drawn. Sir S. Baker first struck a blow at slavery there; Gordon Pasha took up the work, introduced order, built stations, made the people respect his authority, and completely abolished slavery. The present governor, Dr. Emin Bey, rules over a large province with ease, requiring only 1,500 negro troops, divided into small companies in the different stations, to keep order.

In this province crime is unknown, slavery does not exist, the people live at peace with each other, and on the most friendly terms with the Government. About forty Government stations are organised, and a regular weekly post connects them. Were it not for wild animals, one could walk over the entire province with only a walking-stick. The people pay their taxes in cattle and grain, without any trouble, and the only thing which Dr. Emin Bey needs, to make the province pay well, is, as he himself says, one or two Europeans to help him, and more liberal allowance from Khartoum for a year or two. Weighted as it is at the present time with a large debt, the province is not a loss to the Soudan, but it could easily be made a great gain. Cotton, indigo, sugar-cane, rice, &c., are all being cultivated. Ostrich farms have been started, roads made, oxen trained to the yoke; and now that the restrictions against White Nile trade and against settlers have been relaxed, the province will show a large increase of trade and prosperity. A steamer arrives at Lado, from Khartoum, at present every three months; and in the last letter I saw from Emin Bey, he said that he was organising a monthly post overland, as far as the Sobat. That will, however, not be long needed, as the increased trade will require more frequent steamers.

It is possible to open up trade with all these countries glanced at, and if commerce with them be once begun, they will soon absorb English manufactures largely.

The trade with the Mohammedan kingdoms of Central Africa (Wadai, Bornu, &c.), which adjoin the above-mentioned provinces, is at present conducted by two routes—the long and difficult route through the Sahara, and the other from Khartoum *viâ* Kordofan and Darfour. Most of the trade is carried on by the former route; but, were the whole traffic to be diverted to the Soudan route, as would be the case were a railway opened from Suakim to Berber, an immense impetus would be given to the Soudan. But what is more to the point, the people, being able with greater ease and in a shorter time to have communication with the outer world, would turn more of their attention to trade, and the natural wealth of their countries would be within easy reach of Europe.

It may appear to some that the outlet for Bornu is more naturally on the west coast than the east. It must, however, be borne in mind that the trade at present is done by the four months' desert journey across the Sahara to Tripoli, or through Wadai, Kordofan, and Darfour to the east. An additional attraction would be given to the easterly route if it were shortened by the proposed Suakim-Berber railway, so that the idea of extensive trade being carried on with these countries from the east coast is not so wild as it might at first appear.

It is a well-known fact that Africans will trade if they can, and that when once they have felt the subtle influence of barter, they will use every effort to practise it.

That trade can spring up rapidly is shown by many facts, one or two of which I will adduce to prove my statement.

Within a year from the time that the late Gessi Pasha had conquered the slave-dealers in the Bahr-el-Ghazel province, he was able to write that "many looms were at work making Damoor (Baker) cloth, all worked by young negroes" who had been taught by people from Darfour. "The cotton grown there is superior in fineness, softness, and length of

staple to that of America and Lower Egypt." This I can myself confirm, as I have examined it and seen how luxuriantly the shrubs grow, and how well they bear. He had also taught the people to collect caoutchouc, and a large quantity of it had been sent to Khartoum, very much being left behind for lack of transport. Speaking of the Meschera-er-Rek district, he says, "It would be easy to procure 10,000 cantars of caoutchouc yearly, worth about 1,800,000 francs, whilst the expense would not exceed from 80,000 to 100,000 francs." If such results could be obtained in one district, how much might not be drawn from the Monbuttu and Nyam-Nyam lands. There is no doubt that cotton and caoutchouc would alone pay for the administration of these districts, and copal, palm oil, arrowroot, incense, honey, and wax are procurable in large quantities; and any amount of nut oil, which would be of use for the steamers, though not of commercial value at present in Europe, on account of the cost of transport.

In the highlands of the Bahr-el-Ghazel province, the tea-plant, cinchona, and eucalyptus could easily be cultivated. Throughout the whole of these districts the natives manufacture very good pottery. Iron is also abundant, and they display considerable ingenuity in smelting and working it. Their knives, spears, arrow-heads, and bracelets are made in an admirable style, although the primitive stone hammer and anvil are employed. They evince great aptitude in copying European ironware, and would readily adapt any European instruction, and turn it to advantage in the construction of their implements. It is not to be expected that an immense trade would immediately spring up with these people; but were they free, and at liberty to indulge in peaceful occupations, it is reasonable to expect that a large, permanent, and steady trade would be created.

On May 11th, 1880, Gessi Pasha writes:—

"I have collected this year nearly 150 cwts. of caoutchouc, and a great quantity of tamarinds. In the country of the Nyam-Nyams there are whole forests producing arrowroot. We have besides, near the Bahr-el-Ghazel, an immense forest producing gum arabic, equal in quality to that of Kordofan. I have tried cotton planting, and have attained excellent results. We produce iron in sufficient quantity for local use, and, before long, we shall be able to supply the arsenal at Khartoum. This country produces vegetable butter; 300 quintals of honey have been sent down this year to Khartoum, and much bees'-wax collected. Our copper mines, situated to the south of Darfour (Hofrath-en-Nahass), enable us to barter that metal for ivory with the Nyam-Nyams."

Gessi Pasha had also planted 50,000 plantain trees, and introduced lemon trees, pomegranates, radishes, cauliflowers, cabbages, onions, carrots, beans, garlic, peas, cucumbers, beetroot, and maize, all of which I have seen growing well between Djour-Ghattas and Dem-Zibehr. The expense of government of Rohl and Monbuttu provinces had been, per annum, £E546,000; that of Rahr-el-Ghazel, £E1,300,000; total, £E1,846,000. The total cost, under Gessi Pasha, of the Bohl, Monbuttu, Bahr-el-Ghazel, and Nyam-Nyam districts, although almost double the extent, was £E884,688, Full returns of the figures exist in the Egyptian treasury. They show what good management and honesty can do.

One of the causes of expense in the Bahr-el-Ghazel and Monbuttu districts was the large number of native troops employed nominally by the Egyptian Government, but in reality by the slave-dealers. These men were needful on account of the brutal rule of the officials, who were so hated by the natives that a rising could only be prevented by amply-garrisoned forts. They were all bought at a cost of £7 per head; and besides thus costing the Government a good sum yearly, they constituted one of the great means of keeping up the slave trade.

On the 9th of May, 1872, David Livingstone wrote:—

"If Baker's expedition should succeed in annexing the Valley of the Nile to Egypt, the question arises —would not the miserable condition of the natives, when subjected to all the atrocities of the White Nile slave traders, be worse under the Egyptian dominion? The villages would be farmed out to tax-collectors, the women, children and boys carried off into slavery, and the free thought and feeling of the population placed under the dead weight of Islam."

This opinion, written long ago by a man who had a profound knowledge of South African races, has in part been justified; for with the exception of the Equatorial Province, the result has been what he foretold. It is not, however, certain that the Islam religion *per se* has been such a curse to Central Africa. Hardly a real convert has been made, but its influence in banding men together, and in preventing tribal wars, has been of some value, more so perhaps in the countries of Bornu and Wadai than elsewhere.

It is true that, at the present moment, the revolt in the Soudan has not an encouraging aspect; but when regarded from all points, it goes to show that a firm, but at the same time just, government is required. People who are downtrodden, over-taxed, and oppressed in every way, will at last rebel against the oppressor, as is now the case in the Soudan, and, indeed, if good government is not to be introduced there as well as into Egypt, all hope of the looked for commercial prosperity may be given up. But I anticipate better things for that vast region. The revolt will be put down, for although the Madhi's troops are inspired by a fanatical zeal, the better weapons will tell at last, and he must fall. Then the opportunity comes to introduce a new *regime*. Given firm measures, well-trained troops, and just taxes, the country will revive, and commerce be again possible. All the Soudan is not now in revolt. The Equatorial Province Proper, Rohl, Makraka, Mombutta, and the Nyam-Nyam provinces are all quiet; Senaar, Kordofan, and Darfour, are those in revolt, and the Bahr-el-Ghazel province is unsettled for the time.

It appears to me that the opening up of the Soudan, with all its varied resources, will not be accomplished till some better mode of transit can be arranged. Camels are valuable and of much service in some parts, but they are slow, and in these go-a-head days, will not meet the requirements of the age.

I cannot recommend the proposed railway from Cairo, *viâ* Khartoum to Massowah—that must be an enterprise for future years. What is now wanted is a railway from Suakim, on the Red Sea, to Berber, on the Nile. This would at once open up the Soudan to the outer world; and such a line is quite practicable, and could be constructed with ease. The only real difficulty is in the five miles of drift sand at Oback, which, however, can be avoided by a curve. The length of the line would be 250 miles. The cost of constructing a railway in Egypt is about the same as in England, say £10,000 a mile, including engines and rolling stock. The line I propose would cost less, for the rolling stock need not be so costly as in the estimate, the line could be somewhat lighter, and very little would be required, except the laying down of the line, no high embankments, bridges, &c., being needed. Supposing, however, that it cost £2,500,000. The present traffic would pay far more than working expenses, and before long, increased traffic would bring in profitable returns. The working expenses would be less than in Egypt, though the coal should cost somewhat more.

From Berber, good steamers already run to Regiaf, south of Lado, the chief town of the equatorial provinces, and to the Bahr-el Ghazel district, and the Blue Nile.

From Khartoum a railway could be made to Darfour, but for the present would not be needed, and until trade had much increased would be a useless undertaking.

I am well aware that the present camel caravans are not satisfactory, but an improved means of transport could be introduced with ease. Oxen are much used, both for riding and as beasts of burden, and in all parts of the country I have seen, there would be no difficulty in introducing waggon traffic, providing the tires of the wheels were made sufficiently broad. A camel waggon transport system would be far preferable to the usual camel caravans, for fewer camels would be needed, and much heavier loads could be drawn than those which they can carry. I paid much attention to this matter during my journey in Darfour and Kordofan, and am convinced that no difficulties stand in the way of its success.

The great objection to a Suakim-Berber railway arises from the fear of loss of revenue derived from the camel tax. There are, at present, three routes between Khartoum and Cairo, from which heavy camel taxes are forthcoming, viz., Khartoum-Suakim; Khartoum-Berber, Suakim, and Khartoum-Berber-Korosco. Present gain being considered more valuable than any future and greater benefit, the authorities are deterred from giving this scheme their sanction, from the fear that the whole traffic would be diverted to the quicker and cheaper route. They do not realize that the tax can just as well be levied on the exports and imports at Suakim as at Cairo, and that the quicker transport would result in a largely increased traffic, and correspondingly large revenue.

There is no doubt that such a railway, by reducing the cost of transport, and the length of time in transit, would soon increase the commercial importance of the Soudan immensely. It would bring Lado within thirty days from the Red Sea, the Bahr-el-Ghazel within twenty days, and from both these points caravans would push forward in every direction. In fact, this is the most feasible way of opening up Central Africa. It puts Zanzibar out of the question, and would probably be a great rival to the Congo, though both Red Sea and Congo routes will pay, there being room and capabilities for both.

It may be well to explain here what extent of river is navigable by steamers from Khartoum. At all seasons of the year they can pass up to Fazokl, on the Blue Nile.

On the White Nile they can ply as far as to Bedden (4° 35′ 48″ N. lat., 31° 36′ 6″ E. long.), where there is a rapid for about half a mile (I think a little dynamite would make this rapid passable), above which there is another steamer plying between Bedden and Kerrie, 4° 18′ 10″ N., 31° 40′ 28″ E

From this point to Dufli (3° 34′ 35″ N., 32° 20′ 00″ E.) no steam navigation by river will ever be possible; however, a pretty good road already exists. But from Dufli to the Albert Lake, the river is navigable all the year round, and two steamers are now at work on that lake. The River Sobat is navigable for steamers for about 300 miles during most of the year. From Lake No (Mahren-el Bohur), the Bahr-el-Ghazel and River Djour are navigable for more than half the year for small steamers, to a point 5° 10′ 00″ N., 28° 00′ 00″ E. And the Bahr el Arab, which flows into the Bahr-el-Ghazel, may be navigated as far as 24° 10′ 00″ E., 9° 50′ 00″ N., near to the copper mines of Hofrath-en-Nahass for seven months out of the twelve. From these data it will be seen the immense extent of country which would be brought within steam communication, were the Suakim Berber Railway made.

It would, however, not be fair to omit to mention the one drawback to which this splendid system of waterway is liable. I refer to the blocks in the White Nile. South of Lake No, a barrier of this kind has been formed three times in the last thirty years. Once, in 1878, I was a victim, being imprisoned there for forty days. It would, however, be impossible for these blocks to occur were regular and frequent traffic maintained, and there would be no longer any fear of such a disaster if once the Bahr-el-Zeraf were freed. It is a branch of the White Nile, and flows in a more direct course than the usual river channel, which, at Lake No, makes almost a rectangular curve.

Wood for steamers can be procured almost anywhere except near Khartoum, and, even should wood fail, there is an unlimited supply of coarse grass which, when properly prepared, makes admirable fuel. I have mentioned this hindrance on account of the prominence which has been given to the blocks when they have happened; but the rarity of their occurence, and the ease with which they can be prevented, show that they do not constitute any real obstacle to the utilisation of this magnificent system of river communication.

I have found it most difficult, to select from a mass of statistics and information, such facts of interest and value as could be condensed into an hour's paper. I trust, however, that I have succeeded in my desire to show what good reasons there are for believing that a great future is possible for Egypt. Before concluding, I will give a very brief summary of the chief points touched upon in this paper.

As regards the present state of Egypt.

In Egypt Proper, the people are downtrodden, overburdened with an enormous debt, and without the means of turning to account the resources of their fertile land.

In the Soudan is a large extent of country belonging to Egypt, and inhabited by numerous semi-civilised, and many still barbarian, tribes; and this vast region is not a profit to the State, on account of misrule, and a mistaken policy of draining the country for present purposes, without any thought of developing its capabilities for future benefit.

Then, with regard to the future, we find that the people in Egypt Proper are capable of great advance, and of rising, as they have often done before, to a high state of prosperity and wealth. But to bring about this change, they need an enlightened government, just taxation, means provided for the extended irrigation of their land, and encouragement given them to cultivate it.

In the Soudan we see the country annexed, a network of Government stations established, the people used to the Egyptian rule, steamers already at work on the rivers and the Albert Lake—an organization, in fact, already existing which extends over its vast area, and which only needs proper management to insure the development of an extensive and prosperous trade; wise direction under an European Governor-General, liberal support, and honest officials, being necessary to its success.

I do not expect that, within a year or two, thousands of bales of Manchester goods and large quantities of hardware will be consumed by the Soudan; but I am sanguine enough to believe that, if the lines I have indicated be followed, order will appear out of chaos, and that the germ of prosperity, which has undoubtedly been planted at great cost in the Soudan, will rapidly develop its resources, and lead to an extensive and increasing trade, that will prove an advantage to our own commercial enterprise, and greatly add to the prosperity of Egypt.

DISCUSSION.

Dr. MANN reminded the meeting that the Fellaheen, or peasants, who constitute so large a part of the population of Egypt, are really a mixed half-bred race, descended from the aboriginal inhabitants of Egypt and their early Arab invaders. The less numerous Copts are, on the other hand, the representatives of the unmixed Egyptian race. The Bedouins are pure Arabs, but many of them have abandoned their Nomad tent life for permanent houses, although they still breed cattle, sheep and camels. The soil in Egypt originally belonged to the State, and the Fellaheen had a right to its use on the payment of certain taxes, but could at any time be deprived of their holdings of land without compensation. The distribution of the plots was made by the Omdeh, or head man, and by the sheikhs of each village, at their own discretion. These officers were responsible to the Government for the taxes levied on the Fellaheen, and for the supply of men for the military conscription; but they received no salaries for their services, reaping only such indirect advantages as the influential position might entail. The Omdeh was simply the largest landed proprietor of the place, but the sheikhs were elected by the people themselves, to the number of from three to twenty for each village, according to its size and importance. The military conscription, and forced labour for public works, appear to have always entailed a heavy burthen upon the Fellaheen. A great change occurred in the condition of the peasantry of Egypt about the time of the accession of Ismail Pasha, which took place in 1863. The American Civil War had then produced a cotton famine in Europe, the price of raw cotton having risen from sixpence to three shillings the pound. The Nile Valley having been found well suited to the growth of cotton, the Viceroy determined to endeavour to promote its cultivation by introducing seed and machinery. The Fellaheen took kindly to the industry, and in many places large crops were reared. This inaugurated a period of great prosperity. Gold poured into Egypt from the great centres of European manufactures in considerable abundance. When the American War terminated, the Southern States resumed the production of cotton. The Egyptian land had, at the same time, begun to show signs of deterioration or exhaustion. The high taxes upon the cultivators were nevertheless maintained, and large numbers of the Fellaheen were ruined, after being driven to sell their holdings for a very low price. Small plots at first passed into the hands of larger owners; but these, in their turn, soon also felt the pressure of adverse circumstances. It then occurred to Ismail Pasha to avail himself of the opportunity to create large and well-organised estates. In this way the Viceroy soon became the proprietor of one million acres of productive land, which constituted about a fifth part of the cultivated soil of Egypt. The correspondent of the *Times*, in whose recent communications very much valuable and exact information of this character will be found, states that in one village alone with which he was acquainted, and which originally had possessed 7,600 acres of land, there remained only 600 in the hands of the Fellaheen, 7,000 having been appropriated by the Viceroy. The Viceroy also introduced the cultivation of sugar upon his large estates, and to accomplish this had to change the entire system of irrigation. Many thousand labourers were employed to construct dykes and to dig canals, thus having a new and very onerous burthen imposed upon them. Large factories were also built. Sometimes, and in some places, nearly the whole adult male population was employed for these purposes, in forced labour, for several consecutive weeks at a time. The short golden age thus soon gave place to a period of intense sufferings and poverty. A large proportion of the rural population were reduced to the condition of State serfs, and Ismail, by his amateur farming, seems to have gone very far, not only to ruin himself, but a country of five millions of people. It was in this way that all the financial embarrassment, which, it will be remembered, was so forcibly described by by Mr. B. F. Cobb, in a paper read before this Section of the Society in March, 1878, was brought about,* and that the vast encumbered estates, known as the Daira Sanieh, and the Domains, were constituted. Under the rule of Tewfik Pasha, a liquidation of the State debt has been effected, and a new system entered upon. The plan of squeezing the last piastre out of the Fellah has altogether ceased. The Fellaheen are now virtually the possessors of the land they hold, subject to demands upon it for works of public utility, and can mortgage or sell their holdings. The land belonging to each village is distributed into irrigation basins or khods, of which each proprietor has allotments of from a few roods to thirty acres. The land of the Fellaheen may be sold for the payment of arrears due by him to the State. But in a telegram to the *Times* from Cairo, dated February 19, it was stated that the Council of Ministers was preparing a scheme for making money advances to the peasants, through the Credit Foncier of Egypt. In the meantime it appears that there were very large numbers who have already lost their land, and who are reduced to seek a living as day-labourers, or by associating themselves with their richer neighbours under very onerous conditions, in virtue of which the neighbour supplies land, cattle, implements, and seed, and takes three-quarters, or some other agreed upon proportion, of the produce. It is said that a very considerable number of the land-holding peasants are in the hands of usurers, and that the number of landless peasants is rapidly increasing. This, therefore, no doubt is one of the conditions with which the new arrangements of the Egyptian Government will have primarily to deal. It would be remembered that, in the paper which Mr. Cobb communicated in 1878, he entirely agreed with the

* See *Journal* of the Society, vol. xxvi., page 354.

remarks which Mr. Felkin has made on the productive capabilities of the Soudan. He referred in his paper to Mr. McCowan's estimate that Nubia and the Soudan contained 150,000 square miles of arable soil that had not yet been brought under cultivation. Mr. Cobb expressed his belief that the annual cotton production of Egypt might certainly be raised to one million bales, irrespective of a very large yield of both grain and sugar.

Mr. MARTIN WOOD said he felt inclined to dissent very strongly from the line taken by Mr. Felkin in one respect. A large part of the paper related to the Soudan, and the author seemed to have no sort of doubt that that country was a part of, or an extension of, Egypt. Now it appeared to him that it was an enormous encroachment. He would appeal to either the Chairman or Dr. Mann, as a matter of physical geography, whether the Soudan was a part of Egypt; politically and socially, it was an utter mistake for the Egyptian Government—which was, as everyone knew, to a certain extent a foreign Government—to overrun that country. No doubt they did so by superior force. They had a certain organisation and ability, but there was another side to the picture, and Mr. Felkin had himself given indications of the gross misrule and corruption which attended their rule; he also admitted that the Soudan did not pay. He had studied this matter for some years, and he had been accustomed to believe that these encroachments to the south of Egypt had been made because of the ruin to which the country was tending, of its enormous debt to foreign countries, and the gross corruption on the part of their own officials, which even Gordon Pasha found himself utterly incapable of coping with. It might be said, if Egypt were not to civilise the Soudan, how were its resources to be utilised? He was not prepared with an answer to that question, but he doubted whether this was the right way of doing it. Every one, of course, was anxious that these resources should be utilised, but he should be glad to hear from the Chairman whether this region could not be reached in another way from the sea, because the sea was the base of all commerce; rather than by this laborious route through the Nile Valley. The suggestion made of a railway from Suakim to Berber seemed very promising, but he thought the estimate of £10,000 a mile must be accepted with caution. Mr. Felkin spoke of camels being a slow and cumbrous mode of transit, but he also spoke of their being enormously taxed; and he was not sure that if they had fair play, some such mode of transit to the Red Sea would not be preferable to a railway, considering the difficulty of getting fuel; and it would be a great calamity for the country if all the scanty supplies of wood were used for that purpose.

Mr. TRELAWNEY SAUNDERS said the last speaker had thrown out the suggestion that we might look for some administration of the Soudan apart from Egypt, in the direction of the Red Sea; but he would ask him, as a practical man, and would ask any politician whether it was possible to look for any other administration of the regions south of the Nile than the Government of Egypt. Mr. Felkin spoke of the Egyptians proper as distinct from the Copts and other races, but he knew of no Egyptian proper except Copts; they were the sole remnants of the ancient Egyptians. There was no part of Africa which offered larger inducements to Europeans than Abyssinia, from its elevated position, the suitability of its climate, and from the commanding position which it occupied. The Soudan was often spoken of as if it were simply a region connected to Egypt; but in point of fact it embraced the whole zone of population extending nearly from the Red Sea to the Atlantic. The whole of that region, with a very slight exception, was Mohammedan, and they knew that the practice of Mohammedan people was to make an annual pilgrimage to Mecca, and the whole of that population on this pilgrimage passed by Abyssinia, and a considerable number, attracted by the superior advantages of the Abyssinian border, settled there. That gave an immense political and commercial advantage to that region, which we ought to take advantage of. Mr. Felkin had alluded to the occupation of Egypt by Mohammedans as far back as the end of the 7th century. For more than a thousand years Mohammedanism had prevailed over northern Africa. It found these shores, from one end to the other, in the enjoyment of Roman civilisation, and of the protection which it afforded to life, property, and commerce. When the Arabs first invaded northern Africa they found the whole of the country one scene of civilisation, with municipal institutions, and to a large extent with Christian faith, for some of the early fathers of the Church came from northern Africa. But they left it a desert, and it had been a desert ever since. He did not at all question the Asiatic origin of Egypt, but he very much questioned whether all the original inhabitants came across the Isthmus of Suez. One important point touched on in the paper was the bad character of a considerable part of the European population in Egypt, and the encouragement afforded to that population by the present consular arrangements, which really interfered with the administration of justice, and served to support rascaldom in a region which stood in need of all the assistance which European example could give in favour of good government. Another point, which was exceedingly detrimental to European influence in Egypt, was the freedom of foreigners from taxation. We ought to be the last to set the people the example of evading taxation; but, on the contrary, to show our willingness to bear our fair share of it. Allusion was also made to the prospect of making a new canal. Considering the difficulties caused by the silt from the Nile, he believed the proposal to open a new canal from Alexandria to Cairo, then crossing the Nile by lock

gates, and so on to Suez, was one which might be found more and more necessary if a navigable passage across Egypt were to be maintained. At the same time, it was possible to attach more importance to the Suez Canal than belonged to it; for it had not yet superseded the passage round the Cape, and it would be found that the amount of traffic which still went that way was very little less than that which went through the Canal. Reference had been made in the paper to another important matter—the supply of ivory, and the destruction of elephants. If this were allowed, it would be a very serious loss to civilisation and commerce; and it appeared to him that one of the first considerations with any civilised Government should be the preservation of the elephants by proper precautions. The question of slavery was one in which we all took a deep interest, but so long as Mohammedanism was allowed to prevail, so long would slavery be kept up. Unfortunately, we found endeavours to maintain slavery, rather than put it down, on the part of one of the European powers which pretended to be in the foremost van of liberty, for the French Republic was really the main supporter of slavery at present on the African shore. It was, therefore, with the gravest anxiety that he looked on any extension of the influence of that power on or near the African continent; but at the present time, notwithstanding what we knew of the disposition of the French to maintain slavery, we were encouraging the advance of the French power in Senegal, and had even shown a disposition to allow them to acquire Gambia.

The CHAIRMAN said Mr. Saunders had very well said that this was an important subject, and he had almost tempted him to enter into a controversy with him on several points. However, he must try and avoid both him and Mr. Felkin with regard to the origin of Egypt, for although they had laid down the law very explicitly, he must say that he differed from both of them, to some extent, and partly on ground which Mr. Saunders himself had so well stated with regard to the constant intercourse which had taken place between those portions of the old world, particularly across the Red Sea. This question of Egypt was certainly one of the greatest problems of the present time, and in no sense was it one of party politics, but one which all economists ought to deal with. Mr. Felkin had dealt with this matter very ably, as would be expected from one who had been such a close observer, and had seen so much of those countries; and if he ventured to differ from him on those points, it was simply because, from the facts he had given, one was entitled to draw different conclusions. The observations of Mr. Felkin ought to be taken in connection with those of a very distinguished man who at the present moment was special correspondent of the *Times* in Egypt, and it must be recognised that Egypt was not a one-sided question to be treated on any one theory. While Mr. Felkin had dealt with the subject with a great degree of impartiality, he had, to some extent, been influenced by prejudices, which seemed to be also shared by Mr. Trelawney Saunders. Throughout the paper there seemed to be a prejudice against Mohammedanism, which was not justified either by history or by experience. He thought Mr. Saunders had made the most unfortunate allusion to the connection of the Mussulmans with Northern Africa. He said that when the Mussulmans entered Africa they found it was a scene of the most advanced civilisation, and that they reduced it to ruin. Why, surely, he who was so well acquainted with these subjects might have remembered that it was some of our own kinsmen, the Vandals for instance, who had destroyed civilisation in Africa, and that, from that period, the province of Africa declined year by year; and when the Mussulman invasion took place there was very little mischief left for them to do. He forgot that it was these Mussulmans of Africa who, not only in Africa, but more particularly in Spain, gave examples of an advancement in civilisation with which, certainly, the later Roman civilisation in Africa could not vie. It was not necessary to attribute to Islam evils for which other and better causes could be assigned. Religion, or the institutions connected with it, were not the sole cause which should be regarded in these matters; there were considerations of race which must be taken into account, and Islam itself altered according to the population which practiced it. The main point, after all, was the condition of the population of Egypt; and no one could deny the accuracy of that descriptions even to the details of the mode in which they resisted the payment of taxes. That was a trait of character which was to be found described in the correspondence of the younger Pliny, from a Roman governor. The Egyptian population was, by its nature, a slave population; that was its demerit and its virtue. It was a population which worked hard; not only the men, but the women were to be seen working all day long, and past sun-down. In considering the condition of the population, they must not look simply to religion nor to Government, for much as Government influenced a population, a population itself would, to a great degree, determine its own government. The history of Egypt had been that always of a servile population under foreign conquerors, and, consequently, under foreign oppressors. This was the most material fact to bear in mind, because it showed how little value were all the theories about introducing into Egypt self-government. The Egyptians were utterly incapable of it, and one of the keys to the solution of the problem was the acknowledgement of the condition of the Egyptian population. Mr. Felkin had not referred to the Dual Control, and he would not speak of it in any ordinary political shape; but he might call attention to the fact that the Dual Control was naturally the outcome of a most unfortunate alliance—an attempt to constitute an Anglo-French alliance without any natural basis of common interest. The only true

Anglo-French alliance was that of community of trade for some time in the last century, and for some time of late. Much had been said about the merits of the control; but it did look very much as if those laudations came, in a great degree, from those who were connected with the administration of the Dual Control, or the international tribunals. It so happened, as Mr. Felkin's figures showed, that during the period of the Dual Control, the condition of Egypt had improved; but it was not caused by the Dual Control, but from the condition of the Nile, and the increased productions of the country. If, however, what had happened to the population, and what had become of the increased importations, could be examined, it would not appear that the condition of the Fellaheen had materially improved, but rather that of the Sheikh-ul-Belled. Although some most distinguished men had been employed, as Mr. Frederick Goldsmid and others, what was called the Dual Control was a system without responsibility to the Governments concerned in introducing it, or to the Government or natives of Egypt, and without any connection with the creditors of the country; and the result had been a system of jobbery, carried out under English and French auspices, which had been most offensive to the natives of Egypt, and had done much to discredit the two Great Powers. Not only so, but it had done much to interfere with the efforts now being made by that distinguished statesman, Lord Dufferin, who represented her Majesty's Government in Egypt. Another institution, which had been very much belauded, and which, on careful consideration, did not appear to deserve such praise, was the International Tribunals. The result was this, that the land of the Fellaheen, of which they had heard so much as having been acquired by the Turks, was really passing into the hands of the Greeks; the natives were perfectly unable to understand the working of these tribunals. The truth was, there was no necessity for the introduction of what was called European law, or its administration bodily by European lawyers. What was called Mussulman law was a well-defined system. It was no hap-hazard invention of Turks and Mohammedans, but was based on the same principles as all the great systems of law, namely, the same as those of the Roman civil law. There were books to be found upon it in English, French, German, and Russian; it was administered in India, and in Cyprus by Englishmen; in other parts of Asia by Russians, and in Algeria by Frenchmen; and it was taught, at this moment, to students of English law in London itself. Therefore if, instead of introducing a new system, provision had been made for the due administration of Mussulman law, by having in the superior Courts well qualified Europeans—Englishmen trained in India, or Frenchmen trained in the Bureau D'Algerie—the protection of the population would have been provided for, instead of their oppression and robbery, as at present. Another matter, distinct from this, but closely connected with it, was the legitimate protection of Europeans in Egypt. In countries where parole evidence was perjury, where the body of a "murdered man" might be brought into Court, though the murdered man was still living, and where written evidence was forgery, it was absolutely necessary that there should be a protection for the European in criminal matters, but it was easy to provide for that without giving those enormous privileges which, in Egypt, were not required for protection to the European merchant, but which were a protection to the rascaldom of Europe in their offences against the population. Mr. Felkin had dealt with the relations of the bondholders to Egypt, and some persons of great eminence had stated that it was a bondholders' war; the truth was that it had been a bondholders' war almost throughout the proceedings of the Dual Control, and might continue to be a bondholders' war, in the sense that it was a war against the property of bondholders; it had been a war in which the hard-earned savings of the frugal classes of England and France had been warred upon by political experimentalists. True it was that very great frauds had been committed in connection with the various loans which were raised for Egypt, but those robberies had been committed with the participation of Ismail Pasha himself, and with the assistance of men holding high positions as loanmongers in Western Europe, to their great profit. That, however, was not the position of those who were called by politicians the bondholders. The bondholder was a man who had paid a high price for his security, who had placed in it his hard earnings, supposing that he had the support and countenance of the Governments of England and France. Mr. Felkin, like some others, proposed very gravely that, at the present moment, bondholders should be still further shorn for the benefit of the population of Egypt; but what benefit the population of Egypt would get from that he failed to see. Egypt was a country where no large army or large expenditure was required, and there was no reason why the people of this country or of France should be deprived of their property to assist the population of Egypt. How could Mr. Felkin consistently propose to destroy the credit of Egypt with the industrious classes of Western Europe, when at the same time he demanded more capital from them, for the purpose of making a new canal and railways. With regard to the Soudan, it was part of the policy of some persons that the connection of Egypt with the Soudan should be altogether severed, but Mr. Felkin had taken the other ground. The question, however, had been solved in an unexpected manner. The appearance of the Mehdi there had shown that, unless the Soudan was dealt with in some way, most assuredly there would be an invasion of Egypt by his fanatic followers, the effect of which on such a population could not be calculated on with any calmness, and which would embarrass and threaten the peace of a great part of the world. Therefore the question of

the Soudan must be dealt with, but he thought Mr. Wood had not altogether followed the meaning of Mr. Felkin. He expressly intimated that if there was to be any administration by Egyptians, it must be under the control and supervision of competent Englishmen, and by that means alone he expected to obtain any good in the Soudan. That was the main solution, to develop what there was in the upper provinces of Egypt, and to obtain thereby, in a legitimate manner, elements of safety instead of, as at the present moment, elements of danger. At the same time the interests of Abyssinia, Zansibar, and of the Congo routes, must not be forgotten. He did not think Mr. Saunders could claim to regard Egypt in these matters as a civilising power; it certainly had no right to that title, and the only way in which it could be used as an instrument for such purposes must be under such guidance and control as Mr. Felkin had intimated. With regard to camel wagons, he had seen them, and did not expect so much from them as Mr. Felkin did. Some present might have seen in the *Times*, a few months ago, a paper with regard to the ancient gold production of Egypt on the coast of the Red Sea, at Berenice, and he had lately received a letter from the writer of that letter, Mr. W. S. Robb, of Ballarat, now in Australia, from which it really seemed well worthy of examination how far the ancient workings there were carried on, and what prospect there might be of future work. If it happened that there were any resources of such a kind, it would have a very material influence upon any special route of communication with the ports of the Red Sea. In conclusion, he begged to propose a cordial vote of thanks to Mr. Felkin for his very valuable paper.

The motion was passed unanimously.

THIRTEENTH ORDINARY MEETING.

Wednesday, February 28th, 1883; GEORGE MATTHEY, F.R.S., Member of Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Baldwin, Alfred, Wilden Ironworks, near Stourport.
Farnworth, William, Swindon, near Dudley.
Fleming, George, Cathcart-lodge, Tyrwhitt-road, St. John's, S.E.
Hallett, William Brown, 326, Holloway-road, N.
Hammond, Robert, 110, Cannon-street, E.C.
Sonnenschein, Franklin John, Helmsley, Wimbledon-common.
Wisdom, F. W., Rosedale, St. James's, Hatcham, S.E., and 20, John-street, Adelphi, W.C.
Yule, Sir George Udney, C.B., K.C.S.I., 30, Clanricarde-gardens, W.

The following candidates were balloted for and duly elected members of the Society:—

Chamberlin, Frederick, 88, Finborough-road, S.W.
Farnan, Walter, 160, Clapham-road, S.W.
Harris, J. Rees, 105, Malpas-road, Brockley, S.E.
Jeffreys, Richard Lowther, 3, Pembroke-villas, Haldon-road, Wandsworth, S.W.
Knowles, James, The Hollies, Clapham-common, S.W.
Landale, Alexander, 12, Westbourne-terrace, W.
Leadbitter, Thomas Francis, Auckland-house, Brondesbury, N.W., and 144, Leadenhall-street, E.C.
M'Creath, James, 95, Bath-street, Glasgow.
Macdonald, A. R., Arthur's Club, St. James's-street, S.W.
Nordenfelt, Thorsten, 53, Parliament-street, S.W.
Ormiston, James, Castlehill Ironworks, Carluke, N.B.
Petty, Adolphus Gray, The Cedars, Stamford-hill, N.
Tarbat, Viscount, 3, Wilton-place, S.W.

The paper read was—

ON THE INCREASING DESTRUCTION OF LIFE AND PROPERTY BY FIRE.—WHAT IS THE REMEDY?

By CORNELIUS WALFORD,
F.I.A., F.S.S., F.R.Hist.Soc., Barrister-at-Law.

INTRODUCTORY.

This country has recently been passing through what appears to have been a cycle of disaster, in the way of destruction of life and property by fire. This is not the first instance of such an epidemic of fire; it is safe to predict that it will not be the last. It is a supposition, founded upon the teachings of mathematical probability, that all such phenomena as fires, floods, hailstorms, hurricanes, shipwrecks, and other like casualties, are subject to the operation of a law of averages, which, while not understood in its workings, is made manifest in the recorded results extending over a series of years. And, as is to be expected, the wider the extent of the recorded observations in various parts of the globe, the more uniform such law of average is seen to be. Thus if fire losses are excessive in the British Isles, they will be found less general in other parts of Europe; or if excessive through Europe, they will be found light in America, in India, Japan, or Australia; hence a normal average will usually be found to prevail. But occasionally it has happened that an unusual prevalence of fire losses have occurred in all parts of the globe. Such an instance appears to have resulted in the year 1882; but the means of determining whether this be actually so are not yet at hand.

While I have, for the purpose of illustrating the working of the law of averages, compared the occurrence of fires and shipwrecks with the recurrence of floods, hailstorms, hurricanes, and other natural phenomena, it is hardly necessary for me to say that the analogy does not hold good at all points; and for this main reason, that in the case of fires and shipwrecks there comes into play the operation of the human will. What the measure of that influence may be, and how its operation may be traced, will hardly form one of the main subjects for investigation on this occasion. Yet unless it be kept well in view, the reader will fail to comprehend the full significance of my present purpose.

I think it is surprising that heretofore no effort should have been made to collect systematic records of the destruction of property by fire, in the United Kingdom. This circumstance may, perhaps, be traced to the fact that the greater portion of the property destroyed is insured; and hence but small individual loss is usually sustained by the owner. I hope it is hardly necessary to state here that the insurance—useful as it is in its proper aim of protecting the individual owner—does not mitigate the national loss in the smallest degree. A certain amount of property is destroyed by way of fire, the loss in respect of which is defrayed by the community in general, by means of the insurance premiums they contribute; but this nation, in the aggregate, loses in wealth just the amount of the aggregate destruction of property by fire, quite irrespective of any question of insurance.

Practices of Various Countries regarding Fires.

It seems, I again say, not a little remarkable that, while so many efforts are made by Governments and statists to ascertain the amount of the national wealth and its progressive accumulations, so little note should be taken of an element which is always working in conflict with such accumulation. Of all the elements warring against the accumulation of tangible wealth, fire is the most persistent. Earthquakes, floods, hurricanes, hailstorms, frosts, all occasion spasmodic destruction; but the destruction by fire is continuous, and almost seems to justify the belief that this is indeed to be the end of all things terrestrial.

It is not every nation that is thus callous regarding the statistics of fire destructions. Speaking first of Europe, there is Russia—a country which it has become the foolish fashion to speak of as but half-civilised—which has a most complete system of fire statistics, all fires in each province being officially reported to the governor of such province, while their aggregate and certain special details are periodically transmitted to the central government. Of the returns so obtained an enlightened use is made; they are held to indicate the measure of political content or discontent which prevails, and, in some degree, the state of social prosperity. The last three years in Russia have marked a deep political convulsion: the destruction by fire has been greater than in any former period of the history of that country. The fires are abating, *ergo*, the discontent is dying out, or being crushed out—if discontent ever can be crushed out. For the purposes of this illustration, it does not materially matter what the process is—the fact alone is material.

In Germany, I believe, there are no statistical records of fires as such; but they appear in the Judicial Statistics in this manner: in every case where there is the least suspicion of fraud, or wilful fire-raising, an official inquiry is instituted, under the direction of the chief of the police, and the matter is sifted to the bottom, for the safety and protection of the general community.

In France, again, there are no direct statistics of fires; but under the wise provisions of the Code Napoleon—designation now changed to suit democratic notions—every man is held pecuniary responsible for all damage occasioned to adjoining properties: and hence there is the risk of a double inquiry—first, at the instance of the insurance offices which cover the adjoining risks, and if suspicion arises, at the hands of the police. This wise law has led to many precautionary measures—solid, and almost fireproof buildings being one.

I have next to speak of the United States. Here is a population built of all nationalities; and the proportion of suspicious fires has been, and is, prodigious. It is said that the nationalities of which the populations are mainly composed, is, in some degree, at least indicated by the relative proportions of fires.* The buildings, too, are con-

* A comparison has been instituted between the populations of New York and Philadelphia, and the fires which have recently occurred in those cities. The population of New York is given at 1,400,000, and that of Philadelphia at 900,000. The fire loss of the former during the year 1882 was £840,120, while that of Philadelphia was only £433,840, or

structed, in the newer towns more particularly, in a manner to facilitate sinister designs. This is unavoidable in newly and rapidly settled districts. Yet the fire underwriter there really selects his risks as much with a view to the moral hazard as to the physical or structural nature of the building. Further than this, the municipalities have organised and maintained fire brigades, the efficiency of which is nowhere at all approached in Europe, and in comparison with which we are, indeed, far behind in this city. I make this assertion in the face of many and persistent denials; I make it with a full personal knowledge of what I am stating. A man there—speaking of the towns of course—must be skilled in fire-raising, or his designs will, perchance, be frustrated by the alacrity of the fire brigade.

But notwithstanding these wise provisions, the want of detailed statistics regarding the destruction of property by fire, has been long felt. The deficiency has been in some considerable degree met by the enterprise of an insurance journal—the *Chronicle*, of New York. But private enterprise ought not, on principle, to be expected to perform national work. Accordingly, in the preparations for the Census of 1880, measures were taken to obtain records of the property destroyed by fire during a period preceding the census, and in all the States of the Union. This department was put under the superintendence of a gentleman who had received training as an insurance expert, and I am looking forward with much interest to the publication of the returns.

When I note the readiness with which the periodical censuses of that great country (the United States) are made subservient to the growing wants of the community, as compared with our own, where every record of social advancement is studiously resisted by the Ministry, or the permanent officials, I find the contrast a very painful one. It seems that our politicians but too truly represent the density, may I not say, the deplorable ignorance, of their constituencies? I could furnish some remarkable instances in point, if this were the occasion to do so.

While surveying the practices of other nations regarding fires, we must not pass over China. Here the entire district is made responsible for the crimes of the district, of which wilful fire-raising is one of the chief. It may be remarked, in passing, that precisely the same principle applies in England regarding fires wilfully occasioned in connection with tumults, riots, or other incendiary burnings, the whole "hundred" is liable for the damage. Here the liability is limited to the extent of the damage occasioned. In China, the locality is subjected to the infliction of increased taxation in the way of fines; these induce vigilance.

It seems then, that on an entire survey of the nations of the globe, Russia is the only country which systematically records the destruction of property by fire. Hence, in this regard, it is in advance of other nations.

Estimates of Losses by Fire.

While, then, records of fires in a direct shape do not exist, it must not therefore be concluded that there are no means whereby the annual loss from fire is to be estimated. To start with, we know approximately what sum is paid by each of the great nations of the world for protection by means of fire insurance. That does not cover the whole ground, because a good deal of property is not insured at all, and a great deal more is under-insured. Various estimates have been made at different times, and by different persons, of the amount of property uninsured. Sir Frederick Morton Eden, a great authority on statistical questions, thought, in 1802, that but little more than one-third of all destructible property was insured. His aggregate of insurable property was £612,975,000, of which he estimated the amount insured at £223,000,000. In 1875, Mr. Samuel Brown (also a high authority), after an elaborate investigation, arrived at the conclusion that about one-half of the destructible property in houses, buildings, and their contents were insured. His figures were, aggregate values, £1,635,000,000, of which £802,574,000 was insured.* Another quarter

little more than half. But the comparison was still more unfavourable toward New York for the year 1881, when the fire loss of Philadelphia was only £345,146, and that of New York no less than £1,150,000; and this disproportion of fire loss to population is in spite of the undeniable excellence of the Fire Department of New York. The total loss of property by fire in the United States was rather less during 1882 than during former years, but it amounted to about £14,000,000, so that New York bore more than one-seventeeth of the whole loss. In Philadelphia the insurance on the property burnt during 1882 was £1,438,730, or more than three times the amount of the loss sustained.—*Vide Times*, February 3rd, 1883.

* A curious point in our social condition arises out of the preparation of these estimates. The value of buildings can be approximated by means of the assessments for poor-rate. The value of contents has to be estimated. Sir Frederick Eden took the contents as averaging only one-third of the value of the buildings. Mr. Brown estimated the contents as exceeding the value of the buildings by one-half, viz., buildings, £654,000,000; contents, £981,000,000. With the de-

of a century has elapsed, and I think we shall be not very far from the mark if we assume that three-fifths of the insurable value is about the measure of protection.

The next step in the process is to ascertain the amount paid in insurance premiums. Of this, taking one year with another, about 70 per cent. will be required to cover losses, the other 30 per cent. goes for commission, expenses, and profits; or, in view of bad years, and of offices that make losses and not profits on their trading, say 75 per cent. of the premiums is the measure of the losses upon the insured property. The aggregate insurance premiums paid in respect of insurances in Great Britain, is about £7,000,000 per annum.

The losses upon the basis here laid down would, therefore, be £5,250,000
To which add proportionate losses in respect of the property not insured.... 2,100,000

We obtain a total annual loss of.... £7,350,000

The preceding figures relate to the United Kingdom only. An estimate which is to apply to the entire fire losses of the world must be based upon some similar data. I do not propose to enter upon any such detailed inquiry upon this occasion. There is, indeed, no need to do so, for in the *Times* quite recently (27th December, 1882), there appeared an estimate which may very well be adopted to illustrate the argument of this paper, although it will be seen, from what is already stated, that my views, and those of the writer whose figures I propose to quote, do not harmonise; for instance, he takes the ratio of property insured in the United Kingdom at but 46 per cent. of the whole, while I have taken 60 per cent. But over the whole Table there would not be much difference in our aggregate results. As to Russia, I believe, he has understated the aggregate of insurance premiums paid, as also the proportion of property insured. See Table next column.

There are some necessary comments to be made upon the figures so adopted. The country where the largest proportion of the property is insured is France—three-fourths—for the reason already stated; Germany nearly the same, very much on account of schemes of compulsory State and municipal fire insurance. The United Kingdom comes next, Belgium follows closely (43 per cent.), then Canada (30 per cent.), down to Russia with 9 per cent. of its property insured. The average of the whole world, as represented in this Table, shows 43 per cent., or less than one-half of the insurable property insured; while the average rate of premium is just over 5s. (0·27) per cent.

	Fire Insurance Premium.	Rate of Insurance.	Ratio of Property Insured.	National loss by Fire.	Loss per Inhabitant.
	£		p. c.	£	d.
United Kingdom .	6,900,000*	0·25	46	9,100,000	61
France	3,760,000	0·10	75	3,200,000	20
Germany	6,500,000	0·21	74	6,100,000	32
Russia	900,000	0·50	9	21,000,000	60
Belgium	400,000	0·10	43	500,000	22
Scandinavia.....	300,000	0·27	27	1,000,000	35
United States	11,600,000	0·90	15	22,500,000	105
Canada	1,550,000	1·10	30	4,100,000	230
The World	31,910,000	0·27	43	67,500,000	59

The aggregate of annual premiums paid is stated at £31,910,000; the aggregate of property annually consumed at £67,500,000. The loss per inhabitant in the United Kingdom is equal to an annual poll-tax of 5s. 1d. per head of the population; in France, to 1s. 8d; in Belgium, to 1s. 10d.; in Germany, to 2s. 8d.; through Scandinavia (*i.e.*, Denmark, Sweden, Norway), 2s. 11d.; in Russia, 5s. (which again seems under-rated); in the United States, 8s. 9d.; in Canada, 19s. 2d. Now, if in any of these countries, and especially in England, such a tax were suddenly proposed to be imposed upon the people, it would lead to something like a revolution. But in the indirect shape of a national loss, or annual destruction of accumulated property, it is submitted to without a murmur, and without any serious effort towards mitigation. This loss is mainly defrayed by self-inflicted insurance premiums, and hence is borne by the prudent classes only.

Another manner of stating the case is, that the direct annual loss by fire, in the countries enumerated, is equal to the entire revenue of the United Kingdom from all sources—approximating to seventy millions per annum. For this destruction of property arises notwithstanding the existence of fire brigades, and the other appliances of watch towers, fire

velopment of the fine arts, the contents will ever present an increasing ratio. The pictures alone frequently exceed the value of the freehold.

* The actual premiums received by the British fire offices approximates to £10,000,000 annually; but that includes the sums received for insurances in other countries, and for the purposes of this estimate it is necessary to give each country credit for the entire sum paid by it in insurance premiums, quite irrespective of the nationality of the companies by whom the insurances are effected.

patrols, &c., in some countries, as, for instance, the United States, kept up at an enormous expense. If the cost of these be added to the annual losses, the sum of £70,000,000 is, perhaps, exceeded.

Loss of Life by Fire.

I have given precedence, in the treatment of the questions involved in this paper, to the destruction of property, mainly because there are more facts concerning it available for consideration than there is with respect to the loss of life by fire—by fire in the sense here intended. There are elaborate statistics in the annual returns of the Registrar-General regarding the loss of life from burns, scalds, &c., mostly occurring to young children, and to females engaged in domestic occupations, by reason of the inflammability of their dresses. These, however, are not the deaths I am here referring to. In London, during the year just closed, there were 175 persons placed in serious danger of loss of life, by reason of the dwellings in which they were sleeping or working being in conflagration. Of these, happily, 139 were saved, and 36 perished.* Every year presents some such record, alternating with greater or less loss of life. What occurs in London happens in other large, and in some of the smaller, towns; in these latter the life-saving appliances being less available than in London, Manchester, Liverpool, Birmingham, &c.

We have, happily, never had in this country any such catastrophe as that of the Newhall-house Hotel in Milwaukee, United States, recently (nearly one hundred lives sacrificed); or at the Circus in Berditscheff, Russia (nearly three hundred lives lost); or as at the Opera House in Nice, in 1881; at the Ring Theatre in Vienna the same year; or at the Brooklyn Theatre in 1876; yet tens of thousands of persons are exposed to be roasted alive in our theatres, music-halls, concert-rooms, churches, chapels, &c., every evening. But these are not the fires I have in view on the present occasion.

The risks to life, to which I now draw attention, are those which occur in the ordinary course of domestic life. A building is let out, say, in tenements. Shops constitute the ground floor; the upper floor consists of rooms, occupied by lodgers. The shop is found burning; the families in the upper floors must escape as they best can, or they must burn to death. The whole point is, how did the shop become ignited. Was it an accident in the true sense of the word, or was it a premeditated fire? If the latter, where the distinction between it and wholesale murder—called by the law manslaughter. Fires of this class seem to me to be ever on the increase. I much regret that the national statistics do not help us in this matter; and only trust that the familiarity with such records, as presented in the daily and weekly journals, do not tend to blind us to their sad significance.

Fire Protection.

The next important point which arises is, upon whom does the duty of protecting the lives and property of the inhabitants naturally fall? The consideration becomes momentarily complicated from the circumstance that in this country, and some others, the fire insurance offices voluntarily assumed some portion of the duties of fire protection. It is to be presumed they did so, only because the then existing organisations were deemed insufficient for the purpose in view. The life insurance offices have never considered themselves called upon to provide gratuitous medical attendance for the entire community, insured as well as uninsured. The prevention of fires, by which the lives and property of the public are sacrificed, is in truth a branch of national police, and is clearly a State or municipal duty, as much as protecting against thieves and burglars, by whom property is misappropriated and persons maltreated. The fact is, happily, becoming very generally recognised, and I will not dwell upon it. The arguments in support of this view are, in truth, unanswerable.

I regret to have to say, that since the municipal duty of protecting life and property against destruction by fire has been recognised, and in many cases adopted, the degree of protection obtained has been by no means commensurate with the necessities of the case.

* To these may and ought to be added the casualties to the members of the Fire-brigade. There were in 1882, no less than 121 injuries, of which many were very serious, and three resulted in death. Particulars of the accidents are as follows:—

Nature of Accidents.	No. of Cases.
Burns and scalds	8
Contusions	4
Injuries to back, chest, hips, and ribs	15
Injuries to feet and legs	27
Injuries to hands and arms	24
Injuries to head and face	13
Injuries to eyes	4
Sprains and strains	26
Total	121

Here, again, indeed, I am not able to support my argument by a full statistical record—because no such general record exists. But there is one important piece of testimony available, and that consists of the returns of fires for the metropolitan district. On and from the 1st January, 1866, the duty of protecting the metropolis against fire fell, by the authority of Parliament, upon the Metropolitan Board of Works. For this purpose, it took over the staff and appliances of the former London Fire-engine Establishment, which had been supported for many years by the fire insurance offices taking London risks. The following Table furnishes the annual number of fires, with some additional details, occurring since 1866:—

Year.	Number of Fires in London.			Per-centages.		
	Serious.	Slight.	Total.	Serious.	Slight.	Total
1866.....	326	1,012	1,338	25	75	100
1867.....	245	1,152	1,397	18	82	100
1868.....	235	1,433	1,668	14	86	100
1869.....	199	1,373	1,572	13	87	100
1870.....	276	1,670	1,946	14	86	100
1871.....	207	1,635	1,842	11	89	100
1872.....	120	1,374	1,494	8	92	100
1873.....	166	1,382	1,548	11	89	100
1874.....	154	1,419	1,573	10	90	100
1875.....	163	1,366	1,529	11	89	100
1876.....	166	1,466	1,632	11	89	100
1877.....	159	1,374	1,533	10	90	100
1878.....	170	1,489	1,659	10	90	100
1879.....	159	1,559	1,718	9	91	100
1880.....	162	1,709	1,871	9	91	100
1881.....	167	1,824	1,991	8	92	100
1882.....	154	1,762	1,926	9	91	100

The columns are so arranged as to show the proportion of the total fires occurring which had developed into serious conflagrations, as against those which were confined to limited destruction. The services of the brigade in this regard may be readily admitted. But the total number of fires is, on the whole, steadily increasing, presenting annual variations, indeed, not always easy to explain. It will be answered that, of course, as London is ever growing, an increasing number of houses will naturally lead to an increasing number of fires. That argument is met by the following compressed statement of facts, relating to three successive decennial periods:—

	1851-60.	1861-70.	1871-80.
Fires per annum ..	977	1,430	1,795
Do. per million inhabitants ..	389	418	465
Insurance premium	£870,000	£1,130,000	£1,370,000
Per inhabitant	82d.	91d.	95d.

Hence, in the course of 30 years, the fires have increased from 389 to 465 per million of the population, while the ratio of loss from fire to each inhabitant has increased from 6s. 10d. to 7s. 11d. per inhabitant. This does not take into account the lives annually lost.

Remedy.

The practical point we now have to consider is, what is the remedy? It is in the hope of arriving at a rational solution on this important point that I have presented many of the preceding details. I think all the necessary considerations are before us.

Our forefathers, in view of inculcating the sanctity of human life, ordained that whenever a life was wilfully taken, or sacrificed by any species of misadventure (short of absolute warfare) there should be forthwith instituted an inquiry. This was known as a Crown inquiry. Hence crowner, coroner's 'quest, or inquest. By means of such inquiry not only was the cause of death to be ascertained, but also, and more important, who was the offending person. This inquiry was in truth the first step in the direction of punishment. And adequate punishment is the most effective deterrent to the commission of crime.

Now, in regard to fires, I venture to say that none can occur in a crowded city without endangering life. If then life is so usually, and often so eminently, endangered by fire, ought there not rationally to be an inquiry into their origin? Now, inconsistently enough as I think, there is no inquiry unless life be actually lost—no matter by how narrow a contingency the life was saved; no matter the indirect injury to adults, to children, to babes yet unborn, by fright and otherwise. In other branches of police, the consummation of the crime is not the only end regarded. If a burglar breaks into my house, the law assumes him to have contemplated a theft. If a drunken servant, or a negligent neighbour, causes a fire by which some property is destroyed, and life certainly endangered, the law is entirely indifferent concerning it. This

is an instance of the illogical mode in which we are governed. There is no doubt a common law liability as against my neighbour if he carelessly destroys my property; but he may put my life in jeopardy, and walk away without being challenged, for, of the two, the much more serious offence. Is it not time for the people to declare that they can tolerate this stupidity of legislation no longer?

No doubt there has been hovering round this question a sort of sentimental feeling that an inquiry indicates some suspicion of crime. But in the cases of railway accidents, colliery explosions, shipwrecks, and now, happily, in respect of steam-boiler explosions, are not Board of Trade inquiries instituted in the public interest? Yet I may nightly run the far greater peril of being burned in my bed, and if I chance to escape, the miscreant who thus placed me in jeopardy escapes in cold blood.

The prevailing causes of fires in the case of dwelling-houses are unquestionably (1) carelessness, and (2) wrong-doing. Carelessness embraces the sins of the original builder, and of those engaged in subsequent alterations and repairs; negligence of servants in regard to gas, fires, lamps, matches, and explosive and inflammable substances, which enter into domestic use. In business premises, warehouses, &c., the nature of the commodities stored often cause additional hazard. The wrong-doing consists of fires purposely created from feelings of revenge, to conceal thefts, or, too often, for the purpose of defrauding the insurance offices. As to the former, there ought to be a remedy against the offender; as to the latter, they are crimes of the deepest dye. How are the circumstances and motives leading to the fire in each case to be determined, except by means of a careful and systematic inquiry? If any disgrace be attached, it can surely only be against him who either so negligently controls his household, or so recklessly conducts himself, that he dare not face such an investigation! On the occasion of a fire at my own residence, a few years since, it was a source of immense relief to me when the cause—the neglect of the original builder—was made clear. An effective remedy was at once applied.

Conclusion.

The conclusion at which I have arrived, after years of careful consideration, and not a few opportunities for observation, in this and other countries is, that in every case where the cause of fire is not so clear that the chief of the fire brigade, or other competent person to be named, can certify it in writing, there should be forthwith instituted a formal inquiry into the circumstances of the case; and the result of the inquiry should be transmitted to the Public Prosecutor or his district deputy, and also made known by a local record, by means to be determined.

I do not propose on this occasion to enter into the controversial question of whether the district coroner,* the chief of the police, or a new county officer, appointed for this and other purposes, or this purpose alone, shall be the person to conduct the inquiry. All I contend for is, let there be an inquiry, and take care that it is not a sham, by means of which fraud or culpable negligence may be concealed, instead of being openly and fearlessly exposed. The object of the inquiry is to stay the hand of the wrong-doer, by making the chance of detection reasonably certain, instead of, as now, almost impossible. During the past few years, the necessity for more vigorous action in regard to doubtful, or worse than doubtful, fires has forced itself upon the fire insurance offices, and the result has been a considerable number of convictions for arson, and attempted burnings. But I still assert that not one-tenth of the fraudulent burnings are, or can be, brought to light in the absence of certain and independent inquiry. Is it not notorious that hotels which do not pay; that theatres which do not fill; that cotton and other mills, when manufacturing interests are depressed, always burn? In the United States, the melancholy fact has become concreted into the ever apt expression of "Selling out to the insurance offices." But in such cases the insurance offices are not the voluntary purchasers, and further, the losses are all borne by the general public.

It should be stated that in one division of the United Kingdom—Scotland—the Procurator-Fiscal has power to institute proceedings in cases of strong suspicion of arson; and I believe this power has been occasionally exercised. So, again, since the appointment of a Public Prosecutor in England, there is a like power. But in each of these cases there is one important drawback, and that is, the delay which must ensue in putting the

* So long as medical coroners are appointed, the question almost determines itself. The argument in support of medical men being so employed is, that they can best determine the cause of death. It is for the jury, after hearing the evidence, to determine the cause of death. Many frauds are rendered possible under the present inefficient system.

machinery in motion. To make fire inquests —if they are to be so designated—effective, they must be prompt. If the fire occurs to-day, the authorities should be at work to-morrow. Traces become obliterated; escape becomes possible. Therefore, a suitable machinery has to be devised which can meet this essential requirement.

I know of but one source from which determined opposition to this proposal may arise, and this is from the County Boards of Agriculture, which have practically come to exercise a controlling voice over items of county expenditure. But I hope, under the teaching of my good friend Captain Cragie, it may soon become apparent to these astute bodies that the country does already bear the loss of wilful burnings, in the shape of the increased and increasing rates of fire insurance, and in the increased and increasing loss of national wealth by burning. That the remedy which has heretofore remained untried in this country is the only known remedy which has been found efficacious elsewhere, I most distinctly assert.

Quite recently, the Metropolitan Board of Works has declared in favour of such inquiry in regard to fires; * and I believe all who have thought seriously upon the question have arrived at a like conclusion.

In the preceding paper, it will be perceived, I have dealt almost exclusively with the moral aspects of the causes of fires. I know, from various communications received since the paper was first announced, that some disappointment will be felt that I have not even touched upon the mechanical appliances in view of the prevention of fires—many of which are particularly ingenious. But mere mechanical contrivances, however excellent in themselves, can meet and remedy but a very small portion of the evil most needing to be grappled with. I do not, however, desire to shut out their claims from consideration, either now or when any more specially fitting occasion may arise.

* On Friday, January 26, 1883, The Works Committee brought up a report in which they recommended that a letter be addressed to the Home Secretary, in reply to his communication on the subject of a suggestion for holding inquiries into the causes of fires where no death has occurred, informing him that the Board consider it desirable that a public inquiry into the origin of fires should be held in such cases as the Home Secretary or the Board may consider necessary; but that it is the opinion of the Board that the inquiry should be held by some officer, other than the coroner, to be appointed by the Home Secretary, and that the Board should be entitled to attend such inquiry and take such steps as may be necessary to ensure the attendance of witnesses and the production of documents.

DISCUSSION.

The CHAIRMAN, in inviting discussion, remarked that fires had for too long a period been allowed to take place without any inquiry being made as to their causes, and suggested that the most important point for consideration was what changes were required in the law to meet this defect.

The SECRETARY read the following letter from Mr. Payne, coroner for Southwark:—

Fonthill, Reigate, Feb. 22, 1883.

DEAR SIR,—The subject of Mr. Walford's paper is one in which I take much interest. The inquiries into the causes of fires where no death has occurred, were revived by my father some years since, with great advantage to the public; and a short time since I sent to the Secretary of State a copy of a proposed Bill, which I think would answer every purpose, at a moderate expense, viz., that coroners should, with a jury from the neighbourhood, inquire, &c. That Bill was referred by the Home Secretary to the Board of Works, who thought that a special officer should be appointed. I am quite sure that if an inquiry into the cause of all large fires was the rule, and not the exception, that the certainty of inquiry would be a great deterrent to the commission of crime. A part of the inquiry would be as to the state of the building, water supply, &c. I think that the subject is still under the consideration of the Government.

I am, Sir, yours faithfully,

WM. JOHN PAYNE,

H. T. Wood, Esq. H.M. Coroner, London.

Mr. Payne enclosed the following letter, printed in the *Times*, Nov. 5, 1873:—

"SIR,—From my position in the City of London I may, perhaps, be permitted to say a few words on the subject of 'London Fires,' about which a letter signed 'A Fire Office Manager' appeared in the *Times* of November 3, and a leading article to-day.

"In the year 1845, my father, Mr. Serjeant Payne, who was at that time coroner for London and Southwark, and who gave evidence on the subject of fires before a Select Committee of the House of Commons, acting on the old authorities, revived the ancient practice of holding inquests in cases of houseburning where there had been no loss of life, and I, then being his deputy, held a great many of those inquiries. The evidence in the various cases showed that some premises were wilfully set on fire, some were burnt from thoughtlessness in leaving fires unguarded, some from woodwork in the chimneys catching fire, some from carelessness in the use of lucifer matches, and some from the imprudent stowage of inflammable material; and in a case which occurred about two years since in the City, where some black varnish caught fire in a cellar, while a servant, who was burnt and died, was drawing off some camphine from a cask, it was stated that in that cellar there was stowed away inflammable material of various kinds sufficient to blow up the whole street.

"These inquiries, so revived in London and Southwark, were followed by like inquiries all over the kingdom, with manifest advantage to the public, and were favourably noticed in the *Times* of August 27, 1845, and October 10, 1849, and by a number of public journals of those and following years, and were also highly spoken of by several of her Majesty's judges; and the late Lord Denman, when Lord Chief Justice of England, thus expressed himself in a letter to my father:—'Long before I heard of your suggestion that coroners should inquire respecting fires, it had occurred to me as a desirable improvement.'

"Several persons were tried and convicted of arson who, but for those inquiries, would not have been even suspected of that crime, and the late Mr. Braidwood, superintendent of the Fire Brigade, told me that he considered these inquiries highly useful, and that if they had been instituted years before, many persons, who were then to his knowledge at large, would have been transported.

"The exercise of this useful power, however, received a check by the decision of the Court of Queen's Bench in the case of 'Reg. v. Herford'—Coroner of Manchester—reported in 29 *Law Journal*, Q. B., 249, on a writ of prohibition to restrain the coroner from proceeding with an inquiry into the origin of a fire.

"The system pursued in London and Southwark was very simple. On receiving information that a house had been burnt, the coroner granted his warrant to summon a jury and witnesses, and at the close of the case paid the expenses of the inquiry, as on an inquest in case of death, and was reimbursed those expenses, together with his fee, by order of the Court of Common Council, out of the City's cash.

"The Fires Bill, which has been so long before the House of Commons, is far too elaborate and abstruse, and contemplates a considerable expenditure by numerous appointments of public officers; but I see no reason why, reserving power to the Secretary of State, at his discretion, to appoint an assessor in any special case to act with the coroner, it should be necessary to appoint a special officer as 'Fire Marshal' for the Metropolitan Police District, that district extending to only portions of the metropolitan counties; and although by such appointment, within the Metropolitan Police District, the coroner would be ousted of jurisdiction, beyond that district he would have jurisdiction according to the proposed Bill, unless a special officer were appointed for the remaining portion of each county, which would be against the principle of the Bill as proposed, viz., 'That the coroner shall inquire, &c.'

"The proposition of 'A Fire Office Manager,' that the Secretary of State should now appoint temporarily an officer to make these inquiries, would be of little avail, as under such appointment he would have no power to take evidence on oath; and I do not see why the inquiry should be confined to the metropolis, as fires are constantly occurring in all parts of the kingdom.

"The coroner, being already in office, has at hand all the means for carrying into effect the intentions of the proposed Bill at a very small expense, and should be the officer to hold these inquiries, he being an officer appointed by the public, holding office for life, and independent of the Government and all public bodies.

"In London and Southwark the only outlay was that which I have mentioned, and I would venture to suggest that the inquiry should continue vested in the coroner, subject to any special appointment of an assessor, and that the Secretary of State should by a scale fix the expenses of such inquiry and the fee for holding the same, the expenses to be paid by the coroner at the close of such inquiry, and that they, together with his fee, should be repaid to him out of the county rate, in the same manner as on inquests in cases of death.

"I am strongly of opinion that it should be the law that inquiry should be made in every case where any portion of the house was actually burnt, and that such inquiry should extend, not merely to the origin of the fire and if any one is guilty of arson, but also to the structure of the premises and the water supply. I think also that the means of turning on the water should be in the hands of the police as well as the turncocks.

"Certainty of inquiry is the great deterrent of crime, and therefore makes it matter little whether the inquiry be made by the coroner or his deputy and a jury, or by the coroner or his deputy alone, so that it be known that an inquiry will certainly be made. For some reasons I should prefer a jury, say, of half a dozen inhabitants of the neighbourhood, as those who reside in the immediate locality would be likely to be somewhat acquainted with the habits of those frequenting the premises; and, if the coroner be the officer to inquire into the cause of death by houseburning, I see no good reason why he should not inquire into house-burnings where there has not been any death.

"These inquiries, as revived, worked well, gave great public satisfaction, and tended very much to the decrease of incendiarism, and the cost was so small that no one felt it.

"The object of the inquiry is, not merely to ascertain if the premises have been wilfully set on fire, and who may be guilty of that crime, but to find out the cause and the origin of the fire, so that, if possible, the recurrence of a like calamity may be prevented; and the only way to make such inquiry efficient is to hold it before an independent officer, with power to take evidence on oath to make it certain, as simple as possible, and to hold it as soon as convenient after the occurrence.

"Apologising for the length of this letter,

"I am, Sir, yours faithfully,

"WILLIAM JOHN PAYNE,

"Barrister-at-Law, and Coroner of Londo

"Serjeant's-inn, Chancery-lane, Nov. 4."

Colonel WETHERED thought there ought to be not only an inquiry into the causes of fires, but he would go farther, and see that houses were properly constructed to prevent fires, and that property was not over-insured. The fact that a man could insure his property in excess of its value made him careless, and if he were not, his servants too often were, from the feeling that their employer ran no risk. It would be presumptuous in one not well acquainted with the working of fire brigades to make any suggestion as to the extinction of fires, but he thought the heads of such brigades ought to be consulted as to whether the means at their disposal were adequate for the purpose. The prevention of fires depended a great deal on architects and builders, and after that on the householders, who should never allow specially inflammable materials, such as shavings and sticks, to be stored in places where there was a current of air, but this was often done. The means of escape from fire, by means of a trap-door on to the roof, was generally placed in the most dangerous place, at the top of the staircase, where the opening of the trap-door would cause an immediate rush of smoke and flame throughout the whole house. It should be placed inside some room where the inmates could assemble, and by shutting the door escape by the trap in safety. In large hotels special means of escape ought to be provided on every floor. As a rule, fires began in the basement, and spread upwards, and the only means of escape, at present, was by the front windows, from which people often jumped out if the fire-escape did not arrive in time. He might suggest, however, that with the aid of a simple rope and block, which could be placed in charge of the police, persons might easily be rescued from the windows of adjoining houses, which were never very far off, and they could then escape as easily from the back as the front windows.

Mr. A. W. C. SHEAN said the main point raised by the paper was the national loss occasioned by fire, but it was an ill-wind that blew no one any good; and there was one class who lived by fires, viz., the insurance offices, and it was no part of their business to put them out. In London there was the Metropolitan Fire Brigade; but its operations were confined to a somewhat short radius from the Royal Exchange, and the fire-offices paid a certain amount per £100,000 of their premiums towards keeping it up. But when you went outside that radius, how were those whose business it was to put out fires supported? In the United Kingdom there were 25,000 volunteer firemen, who received nothing for their services, on whom the entire duty devolved. The fire-offices paid nothing to them, and they often had great difficulty in recovering even their expenses out of pocket. Hampton Court Palace would have been burned to the ground but for the volunteer fire brigade. No doubt, an inquiry into the causes of fires would be an excellent thing; that many cases, the cause was ascertained; but even when the insurance offices were told that the cause was doubtful—which was all the reason that the officer could give, but which conveyed something more—it often suited the insurance office to pay the loss rather than make a stir, for fear of losing business. If the inquiry were conducted by a public officer, the insurance offices would be relieved of this feeling, and their position would be very much strengthened. He had lately had charge of a number of experiments with regard to the extinction of fires, and he thought it a great pity that where anything was proved to be useful, Government did not come forward and assist the inventor. In London, there was a rate imposed by the Metropolitan Board of Works for the support of the Fire Brigade, and it was proposed to increase it from ½d. to 1d. in the £; but he thought the system was open to exception. In ordinary dwelling-houses, the risk was very limited, and the brigade was quite able to cope with any fires which arose in such buildings; the necessity for increased expenditure all arose from the existence of large factories and warehouses, and, therefore, he thought the owners of those properties ought to pay the increased rate required.

Mr. CHARLES WHITE thought an inquiry into all doubtful cases would be of immense advantage, and that fire brigade officers should have the power of saying when an inquiry was needed; and he did not think it would be so often as some might imagine. The Committee of the House of Commons in 1867 agreed that the coroner should initiate these inquiries, and he did not see why they should not do so. With regard to the escape from fires, the means must come from the outside, the inmates being often too terrified to be able to do anything. Fire-escapes were of great service, but in many cases in the suburbs they would be useless, on account of the fore-courts to the houses; and he would recommend, therefore, the adoption of a plan he had seen in Liverpool, viz., the use of a very long ladder, with two wheels at the end, so that it could easily be moved, and this might be in charge of the police. The fire at Hampton Court Palace was extinguished by the Palace Fire Brigade. There was a stationary engine; hydrants were laid on over the palace at 60 or 70 lbs. pressure, and directly the fire occurred, these were screwed on, and it was soon extinguished.

Mr. WARREN said he was a tradesman at Hampton Court, and belonged to the fire brigade, which was entirely a voluntary one. The superintendent, it was true, was employed in the palace, but the majority of the members were entirely unconnected with it.

Mr. WHITE, referring to the great fire in Wood-street, said the only way to prevent that class of fires was to divide the risk, by cutting up the warehouses into smaller divisions, and by carrying the party walls

hole or hoist in warehouses was a great source of danger, and there was also an evil in the accumulation of empty packages, straw, &c., in the basement.

Mr. REDMAN thought a great many fires which had occurred in the metropolitan area, arose from neglecting some of the provisions in the various Building Acts which had been passed from time to time. He knew of several places which had been burned down over and over again, and this arose in many instances from ignorant or wilful evasion of the statute. Apparatus for heating, and various manufacturing appliances, were frequently introduced, after the surveyor of the fire office had inspected the premises, and this was especially the case in certain parts of the eastern and northern suburbs, where large buildings, originally dwelling-houses, had been converted into factories or places of business. He knew of several cases where steam-engines had been introduced without proper precautions being taken, which the Act of Parliament required.

Mr. DAVID NASMITH remarked that none of the previous speakers seemed to have touched upon the main point involved in the paper, if he understood it aright, and that was, whether the life of the British subject, which was imperilled by fire, was to be a question for the consideration of the Government, or the speculation of private enterprise. This was a most important question, and the whole nation was indebted to Mr. Walford for bringing it forward. It had been said that insurance offices found it answer their purpose to pay, and not to inquire; and that was a truth perfectly well known to lawyers: but that involved the very point he had mentioned. Mr. Walford had referred to Russia, and shown that, in this respect at least, she was superior to ourselves. In fact, England was one of the strangest countries the world had ever seen. Nearly every good thing we had commenced in private enterprise; but the time had come, in many instances, when private enterprise failed to meet the position, and in time it would fail to meet many others. He believed the time would come—and the sooner the better—when the Government would take the premiums, and manage the whole business. He had come there for a special purpose, viz., to refer to the invention of Mr. MacLellan for extinguishing fires, but as he found the subject different from what he had expected, he would not say any more about it.

Mr. DONOVAN said he was interested in a patent fire alarm, which possessed the advantage that it would indicate any sudden rise of temperature, even of two or three degrees, if required. He believed this would be of great value in hotels and large buildings, where there was a watchman constantly on duty.

Mr. SWINTON said he gathered from the paper that the remedy would be the fire inquest, but he feared the practical difficulty would be to decide when it was necessary. Perhaps a rough and ready

amount of damage. He also suggested that either insurance companies or manufacturers might arrange to let out Extincteurs or "Fire Queens" on hire, as gas companies did meters, for very few people would go to the expense of purchasing them, and yet everyone would admit that the very best thing for a fire was a small quantity of water at the very beginning.

Mr. LIGGINS thought the most valuable suggestion in the paper was that of inquiries into the causes of fires, because when the cause of a misfortune was discovered, there was some chance of applying a remedy. It had fallen to his lot, on two occasions, to be on a special jury which had to try an important action on a fire policy. In one case, that of a West-end tradesman, the company disputed the claim because they did not believe the plaintiff had the quantity of goods on his premises that he claimed for, and the jury at first entertained the same view; but the case lasted two or three days, and the jurors took the opportunity to inspect the shops of similar tradesmen in the locality, and unanimously came to the conclusion that the claim was an honest one. In the other case, the claimant was strongly suspected of arson, and his maid-servant lost her life in the conflagration; and there it was conclusively proved that not a shilling's worth of the goods for which he claimed were on the premises at the time of the fire. Of course he lost the action, but there was no prosecution instituted against him. In each of these cases, an investigation on the spot, immediately after the fire, would have been eminently serviceable, and, in the latter case, he had no doubt it would have ended in the criminal being punished. In his own parish of Kensington, he recollected the case of a fire breaking out in extensive premises next door to the fire-brigade station, and though the engines and men were on the spot, it was half-an-hour before a drop of water could be got. This was by no means an isolated case, and seeing that the water was charged so highly, he thought the companies ought to be called upon to give a constant supply.

Mr. OWENSMITH thought all the preceding speakers had begun at the wrong end. It was very important to extinguish fires when they occurred, but it was better still to prevent them, and in order to this end, he thought the public should be taught that they were not irresponsible in the matter. It was a very common observation when anything was said about precautions against fire—Oh! I am insured. It seemed to him that in all cases, culpable neglect should be treated as criminal neglect.

Mr. AUMONIER was disappointed that no one had referred to special methods of preventing fires, such as the employment, in building, of wood chemically prepared, so that it would not burn.

Mr. SHEAN wished to supplement what he had said by remarking that the Hampton Court Fire Brigade was entirely voluntary, and that in his

of a fire should be in the interest of the public, not of the insurance offices.

Mr. REYNOLDS said he confirmed generally the statistics brought forward by Mr. Walford, but he did not think there was such an excess of fires now as compared with formerly, as the figures showed; not that he challenged the figures, but since the existence of the Fire Brigade the returns were more full. No doubt the fire insurance companies were interested in the question, but not so much as was supposed, because if fires were numerous the rates were high; if few they were low. Nor were they interested in putting out fires; that was the duty of the community, as was recognised in all recent Acts of Parliament; the contract with the company was to indemnify the insured, not to put out the fire. The practical point was, what steps should be taken to diminish the number of fires, and there could be no doubt that the more they were inquired into, the more they would diminish. The difficulty which had always arisen, which no Government had yet been bold enough to face, was who was to pay for it, and who was to conduct the inquiry. Although the coroner's court had the advantage of being moveable, the coroner was not the most fit person, being frequently a medical man, whereas a person of some legal training was required. No doubt this was one of the good things which would come in time, and then not only would the causes of fire be discovered, but defects in Building Acts also, because fires were increased by defects in building, and they were not put out as quickly as they might be, from a deficiency in the water supply; and when this was proved, probably the next step would be the recognition that the municipality or the Government should supply water, and not a trading body. It would be impossible for every fire to be inquired into, because the fire-engines in London were called out, on an average, every four or five hours; but the public prosecutor did not set his machinery in motion against every man who was taken up by the police, and if some discrimination were exercised, great benefit would arise from inquiries; not only dangerous buildings, but the dangerous classes would be discovered. There was a man coming out of prison this year who was the cause of more than a hundred fires, which he had started for the sake of the shilling he got for calling the engines; so that it was not always the prospect of a large amount of gain which caused incendiarism. Servants often set fire to buildings to conceal robberies; and all these things would come out, if inquiries were instituted.

Mr. SWAN said the number of great fires would be very much restricted if greater precautions were taken, in building, to separate different floors and different buildings from one another. The so-called fire-proof doors were often quite illusory, as was shown in Wood-street. It was the object of the owners of property to reduce the cost of building as with the strict letter of the Building Act, which, experience showed, was not sufficient.

The CHAIRMAN, in calling on Mr. Walford to reply, invited him to give further information as to the mode in which inquiries into the causes of fire were carried out in Russia.

Mr. WALFORD said the mode adopted there was to throw any suspected person into prison, and let him remain there until he could prove his innocence; which was not an easy matter under such circumstances. Although he held up Russia as a model, with regard to the collection and use of statistics, he did not do so as regards her judicial system or mode of punishment. Speaking generally, he was bound to say he was somewhat disappointed with the result of the discussion, and but for his friend, Mr. Reynolds, who was able to read between the lines, and gather the full effects of the points he had introduced, he should have been completely disappointed. He had not thought it necessary to state all the details which would be elicited by an inquiry into the causes of fires, or rather of all suspicious fires, but it was evident that such inquiries, if efficient, would answer all questions. Was it the work of an incendiary; was the person over insured; was the water supply deficient; were the appliances deficient; had the provisions of the Building Act been neglected? An efficient inquiry would answer all the points which had been raised. The Parliamentary Committee, the Board of Trade, and everyone who had brought their mind to bear on the subject, had come to the conclusion that an inquiry was desirable. Then came the question, who was to conduct it. How was the machinery to be formed? He was glad to hear Mr. Shean stand up for the volunteer fire brigade; though his experience of them in America and Canada had not been altogether favourable. In this country, as a whole, they were generally well managed, when they did not all become commanders or captains, because in that case it became rather awkward when there was a fire. It was clearly not the duty of insurance offices to take any part in directing the inquiry; their duty was to charge such premiums as would cover the losses and leave the profit, however the losses might arise; it was the duty of the persons who paid the premiums to organise a system which would detect fraud, and, as a consequence, keep premiums down to the normal rate. The great point he wished to make was, that this was a public question, and a public question only, and he was glad to think that at present there was a disposition to move, if the public would only express a wish on the subject. Of course, such a system would cost money. All the inquiries in a year would perhaps cost as much, or almost as much, as one day's experiments with big guns at Woolwich, but the result would be far greater; and it was a cost which would repay itself. Then how could it be done? A coroner was not the man;

could not expect them to go into a house after a fire, and arrange a mass of details so as to make them useful. You must have either a legal coroner, or an independent officer. An independent officer would cost money, and there would be the difficulty that as he was only occasionally required in various parts of the country, he would not be always on the spot, and valuable time would be lost. If a fire broke out at night, the jury should be called in the next morning, and see the state of things —notice the shavings under the stairs, turpentine bottles or petroleum cans hardly dry, and so on. All those things which an experienced eye would detect at once should be seen by the jury, and the Public Prosecutor would in all probability have a strong hint as to who caused the fire. If the duty were performed in this way, it would be for the common good of mankind.

The CHAIRMAN then proposed a vote of thanks to Mr. Walford, which was carried unanimously, and the proceedings terminated.

Miscellaneous.

SOCIETY OF ARTS PATENT BILL.

The following report of the proceedings in the House of Commons, on Tuesday, February 27, relating to the Patents for Inventions Bill (No. 2), is taken from the *Times*:—

Sir J. LUBBOCK, in moving the second reading of the Bill, said it was the same as that which he had had the honour of introducing last year, and to the second reading of which the House last year agreed without a division. He hoped they would adopt the same course on the present occasion, and that it might be then referred to the same committee as the Bill introduced by the Government. He believed the present Bill was a good one, and felt he might say so, as the merit was not his, but belonged to the Society of Arts, and especially to Sir Frederick Bramwell. He introduced it on behalf of the Society of Arts, and in their name he asked the House to assent to the second reading. It was a comprehensive measure, and he knew that on some of the clauses there would be discussion, but he thought they could be better considered in committee.

Mr. CHAMBERLAIN said that he should not oppose the motion of the hon. baronet. At the same time he did not think that it was altogether satisfactory to agree to the second reading of a Bill without discussion. The views of the framers of the present Bill, and of the Bill introduced by the hon. member for Glasgow, might have been fitly expressed in the form of amendments to the Government Bill on the

The Bill was then read a second time, as was also the Patents for Inventions (No. 3) Bill, on the motion of Mr. ANDERSON.

SERICICULTURE AT LYONS AND SMYRNA.

The following particulars are obtained from three official consular reports to the American Government on continental silk culture, which appear in the Washington Blue-book for August, 1882:—Consul Peixotto, of Lyons, on the 29th June last, says that *pebrine*, which for twenty years has sterilised the French silk crop, has almost completely disappeared. Recent experience shows that the worms are now as healthy as at any previous epoch, although the supply of food has proved inadequate. This has been owing to the fact that some years ago, when sericiculture was plunged in gloom on account of disease, thousands of mulberry trees were uprooted, and other shrubs, notably the vine, planted in their place. Phylloxera has, in turn, so materially interfered with viticulture that, encouraged by the decrease in the virulence and prevalence of the various silkworm maladies, the peasantry are once more turning their attention to the mulberry, and a revival in sericiculture on a large scale in France is confidently anticipated soon. "There are few industries," Mr. Peixotto continues, "that present so much attraction to those engaged in it as that of silk. Youth is scarcely ever too young, old age too feeble, but what work, aud pleasant work, may be fonnd in this branch of agriculture and commerce."

Again, writing to his Government, on the 5th July, the same gentleman, after a survey of the mutations of the French silk industry up to a recent date, alludes to the success achieved by M. Pasteur in combatting the various silkworm diseases by the aid of the microscope. It appears that Pasteur's method of examination made way but slowly among the silk farmers of France and elsewhere. During the silk season of 1880 and 1881, however, his system has been thoroughly tested, with the result that the appetites of the immense mob of hungry, healthy, ravenous silkworms produced could scarcely be satisfied by the diminished harvest of mulberry leaves available. Since then the lessons taught by the distinguished savant have been still further acquired to such purpose that, in 1882, with a purposely limited, but entirely healthy brood of worms, enough food was forthcoming, and the hitherto dreaded *pebrine* and *flachrie* are quickly subsiding into mere phantoms of the past. But the reeling difficulty remains, and is likely to prove a source of anxiety for some time to come, unless some marked improvements in the mechanical treatment of cocoons be effected. Whilst sericiculture continued moderately prosperous, before the rapid spread of the various silkworm maladies unhinged the industry, the

however, many of the silk mills were diverted to other purposes, so that the present reeling and spinning plant is said to be short by at least 30 per cent. Nor is this the worst. The mere augmentation of machinery and buildings might easily be accomplished, but as the former workers are scattered, or have attached themselves to other employments, skilled labour, which requires several years to train, is scarcely to be obtained. Hence, as Mr. Peixotto justly argues, the necessity for automatic machinery, he invention and perfecting of which he presses upon the notice of American engineers.

On the same date, Vice-Consul Griffitt, of Smyrna, contributes a report, in which he relates the results of his own experiments and experiences in his struggles with silkworm diseases in Asia Minor. The loss suffered by Turkey, he says, since 1857, is incalculable. "I remember the time when the wife of every gardener in the vicinity of Smyrna obtained from her crop of cocoons a sufficient return to enable her to pay for the clothing of her family for the entire year. This fatal disease (*pebrine*) swept away our beautiful indigenous races, and this branch of industry was almost abandoned." Mr. Griffitt then refers to the mediocrity of the Japanese silkworms, which were subsequently introduced to fill the gap, and informs us that "it requires 250 fresh cocoons of the indigenous race to weigh 1 lb., but 500 of the Japanese, and the quality of the silk is much inferior. I obtained, some years ago, a quantity of indigenous *graine* of a very fine race, but very much diseased. I raised the worms, from the moment of hatching, in separate cells, in order that the diseased ones might not infect the healthy, and from the few healthy ones I obtained my present race. From 1 ounce, of 30 *graines*, I obtain, invariably, from 150 to 155 lbs. of fresh cocoons, 12 lbs. of which yield over 1 lb. of silk of the best and finest quality. Another great advantage of this improved race is that it yields only from 4 to 6 per cent. of double cocoons, while other races have from 15 to 30 per cent."

After paying a high compliment to M. Pasteur, whose system of egg-examination he follows, Mr. Griffitt describes the process of microscopic inspection, and the silk-rearing industry generally, concluding by assuring his readers that, by hatching silkworms from healthy eggs, and feeding under proper precautions, a good crop of cocoons must be obtained. Upon the particulars of this department of the subject it may be unnecessary to dwell, as it is understood that a manual for sericiculturists will soon be published by that gentleman.

Correspondence.

CULTIVATION OF CHINA GRASS.

Referring to an extract in your *Journal* from an

that the slow progress in the general utilisation of this most valuable textile material has not been caused by the absence of supply, as, for the last twenty years, I have, with rare exceptions, held ample for all requirements, and have, to-day, over 100 tons in London. It is well known the plants will grow luxuriantly in Southern Europe, Algeria, &c., and even in England, but no fibre has yet come to market in commercial quantities; and, I believe, for many years to come, China grass will be the cheapest, as it is the best in quality. An immense amount of energy has been wasted in experiments conducted in ignorance, apparently, of what has hitherto been done with this material, which might have been directed into more practical channels. I have for years made this material my private study, and being in correspondence with nearly every one either working or cultivating it, I shall be glad to place the best information on the subject at the service (gratuitously) of any one seriously interested in the matter.

C. E. COLLYER.

141, Fenchurch-street, London,
26th February, 1883.

ANDERTON CANAL LIFT.

As the Anderton Canal Lift, spoken of by Professor Perry in his Cantor Lectures on "Hydraulic Machinery," is a work of some considerable importance, and the only one of its kind at present constructed, it may interest your readers to know that the fullest account that has been published of it is given in a paper, written by myself, which was read before the Institution of Civil Engineers on March 21st, 1876. The details of design and construction are there described, and Messrs. Emmerson, Murgatroyd and Co., of Stockport, have due credit accorded to them as contractors for the work.

SIDINGHAM DUER.

6, Westminster-chambers, Victoria-street,
London, 27th Feb., 1883.

General Notes.

INSTITUTION OF NAVAL ARCHITECTS.—The annual meetings of the Institution will be held in the rooms of the Society of Arts on Wednesday, Thursday, and Friday, March 14th, 15th, and 16th.

ELECTRICAL COMPETITION IN FRANCE.—The French Minister of Public Instruction has made a communication to the President of the Académie des Sciences to the effect that the prize of 50,000 francs (£2,000), founded by the decree of 11th June, 1882,

upon the following applications:—Heating, lighting, chemical action, motive power, the transmission of messages, and the cure of disease. The competition is open to scientific men of all nationalities, and will remain open until 30th June, 1883. The commission charged with examining the claims sent in will be appointed by the Minister of Public Instruction; and their names will be published in the *Journal Official* of the French Republic.

THE ST. GOTHARD RAILWAY.—Early fruit and vegetables are now being conveyed by the St. Gothard Railway without transshipment from all parts of Italy to Ostend, Antwerp, and Rotterdam, whence they are taken by fast steamers to London and other English ports. The Great Eastern Railway Company alone is stated to have carried over 6,000 tons of these goods, *viâ* Antwerp and Harwich, in a few months. Italy is also receiving from Germany large supplies in return. In two months, after the opening of the St. Gothard route, the Germans despatched 40,000 tons of coal, 107 tons of unmanufactured iron and hardware, 14,000 tons of machinery, 693 tons of copper, 17,409 tons of spirits, 1,446 tons of paper, and 76 railway wagons. From returns lately published, it appears that the result of the working of the railway, from June to December, is satisfactory. Excepting June, which was a broken month, August yielded the best return, 993,000 fr.; and December the lowest, 685,000fr. The working expenses were the lowest in August and September, not exceeding 300,000 fr., but rose in December, owing to the necessity of keeping the line clear of snow, to 426,000 fr. The excess of receipts over expenses during the seven months makes a total in round numbers of 3,500,000 fr. (£140,000). The goods traffic shows a steady increase, the receipts from this source being 500,000 fr. in December, against 380,000 fr. in August. The falling-off in the winter returns arises from the diminution in the number of passengers. In August, 117,000 passengers travelled over the line; in December only 50,000. The number of passengers carried by the company since the opening of the line last June is 601,000. The large snowploughs which have been employed have proved equal to the task for which they were constructed; but where the drifts were too high for them, workmen had to take up the work. There have been no interruptions of traffic on account of the snow drifts as was expected.

THE LIBRARY.

The following have been presented to the Library:—

Reeve, Mrs Henry.—Cookery and Housekeeping; a Manual of Domestic Economy for Large and Small Families. (London: Longman, Green and Co., 1882.) Presented by the Author.

Pim, Captain, R.N.—Gems from Greenwich Hospital. (London: Clayton and Co., 1881.) Presented by the Author.

Benvenuti, F. F.—Episodes of the French Revolution from 1789 to 1795. (London: Simpkin, Marshall and Co., 1880.) Presented by the Author.

Walch, Garnet.—Victoria in 1880. (Melbourne: George Robertson.) Presented by the Trustees of the Public Library, Museums, and National Gallery of Victoria.

Dawson, James.—Australian Aborgines; the Languages and Customs of several Tribes of Aborigines in the Western District of Victoria, Australia. (Melbourne: George Robertson.) Presented by the Agent-General for Victoria.

Board of Revenue, Madras.—Proceedings, 11th August, 1882, and 23rd September, 1882, Relating to the Government Farms at Saidápet. Presented by W. R. Robertson, Superintendent of the Government Farms.

Caine, T. Hall.—Recollections of Dante Gabriel Rossetti. (London: Elliot Stock, 1882.) Presented by the Publisher.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

MARCH 7.—"The History of the Pianoforte." By A. J. HIPKINS. JOHN STAINER, M.A., Mus. Doc., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at Eight o'clock:—

MARCH 20.—"Social and Commercial Aspects of New Zealand." By WILLIAM DELISLE HAY.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings at Eight o'clock:—

MARCH 22.—"Self-Purification of River Waters." By W. N. HARTLEY, F.R.S.E. (This meeting was previously announced for March 8th, but the date is now postponed to March 22nd.)

INDIAN SECTION.

Friday evenings at Eight o'clock:—

MARCH 2.—"Agriculture in Lower Bengal: with some Notice of Tenant Right, &c." By W. S. SETON-KARR. The Honourable Sir ASHLEY EDEN, K.C.S.I., will preside.

CANTOR LECTURES.

Monday evenings at Eight o'clock:—

Second Course, on "Solid and Liquid Illuminating Agents." By LEOPOLD FIELD.

LECTURE VI.—MARCH 5.

Ozokerit, and other mineral sources of light. Manufacture of Candles. Survey of the candle trade and the various inventions and industries excited

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Leopold Field, "Solid and Liquid Illuminating Agents." (Lecture VI.)

Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Adjourned Discussion on "The Recommendations of the Royal Commission on Agriculture."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. Harry Olrick, "A New System of Treating Fæcal Matter."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. W. Lant Carpenter, "The Conversion of Oleic Acid into Palmitic Acid on the Manufacturing Scale."

British Architects, 9, Conduit-street, W., 8 p.m. Special General Meeting to elect the Royal Gold Medallist, and to receive Report of Council on Awards of Medals and Prizes for 1882-83.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Mr. J.E. Howard, "Certain Definitions of Matter."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Seymour Haden, "The Great Masters of Etching."

TUESDAY, MARCH 6...Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Mr. W. Carruthers, "Farm Seeds and their Adulterations."

Royal Institution, Albemarle-street, W., 3 p.m. Professor R. S. Ball, "The Supreme Discoveries in Astronomy." (Lecture III.) "The Law of Gravitation"

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. Ralph Hart Tweddell, "The Productive Power and Efficiency of Machine Tools and other Labour-saving Appliances Worked by Hydraulic Pressure." 2. Mr. Alexander McDonnell, "Stamping and Welding under the Steam Hammer."

Science Society, King's College, Strand, W,C., 8 p.m. Mr. H. Jackson, "Gun Cotton."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m. Mr. H. Rassam, "Recent Discoveries of Ancient Babylonian Cities."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. The Rev. H. S. Gorham, "Coleoptera of the Family Erotylidæ." 2. Dr. J. Gwyn Jeffreys, "The Mollusca procured during the *Lightning* and *Porcupine* Expeditions." (Part VI.) 3. Mr. H. O. Forbes, "Note on a Species of *Myzomela* from the Island of Buru."

WEDNESDAY, MARCH 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. A. J. Hipkins, "The History of the Pianoforte."

Geological, Burlington-house, W., 8 p.m. 1. "A Description of the Gray and Milne Seismographic Apparatus," to be exhibited by Mr. Thomas Gray. 2. Pev. G. T. Whidborne, "Notes on some Fossils, chiefly Mollusca, from the Inferior Oolite." 3. Professor W. J. Sollas, "Some Fossil Sponges from the Inferior Oolite." 4. Professor H. G. Seeley, The "Dinosaurs from the Maastricht Beds."

Entomological, 11, Chandos-street, W., 7 p.m.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Mr. Walter Gibbons, "Uranium Oleate." 2. with Data Illustrating the Results Obtained in its Preparation by the Process of the British Pharmacopœia." 3. Mr. D. Morris, "Cultivation of Cinchona in Jamaica: Notes on Specimens of this Bark, &c., sent to the Pharmaceutical Society of Great Britain from the Government Plantations."

Archæological Association, 32, Sackville-street, W., 8 p.m. Mr. Alfred B. Wyon, "The Great Seals of Henry IV., V., VI., and more particularly the Second Great Seal of Henry IV."

Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

Royal College of Physicians, Pall-mall East, S.W., 5 p.m. Dr. J. E. Pollock, "Modern Theories and Treatment of Phthisis." (Lecture III.)

THURSDAY, MARCH 8...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Professor Armstrong, "Gas Stoves."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. J. Orrock, "True Art."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Spectroscope and its Applications." (Lecture VIII.)

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Prof. Cayley, "Monge's Memoir 'Sur les Emblais et les Remblais.'" 2. Mr. J. W. L. Glaisher, "Calculation of the Hyperbolic Logarithm of π."

FRIDAY, MARCH 9...Royal United Service Institution, Whitehall-yard, 3 p.m. Colonel Herbert Stewart, "The Future of Cavalry."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Professor George D. Liveing, "The Ultra-violet Spectra of the Elements."

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Lumleian Lecture.) Dr. A. B. Garrod, "Uric Acid in its Relation to Renal Calculi and Gravel." (Lecture I.)

SATURDAY, MARCH 10...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. Shelford Bidwell, "Method of Measuring Electrical Resistances with a Constant Current." 2. Mr. W. Lant Carpenter, "Some Uses of a New Projection Lantern."

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. Statham, "Music as a Form of Artistic Expression." (Lecture I.)

CORRECTION.—In the last number of the *Journal* (p. 318, col. 2) a typographical mistake was made in the final correction, by which the first line of the first paragraph and the first line of the second paragraph were unfortunately transposed:—

Line 4, *for* compound, *read* portable.
Line 11, *for* portable, *read* compound.

It was Messrs. Ransomes and May who exhibited in 1841 the first portable engine, and Messrs. John Fowler and Co. who exhibited in 1879 the first

Journal of the Society of Arts.

No. 1,581. Vol. XXXI.

FRIDAY, MARCH 9, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The sixth and concluding lecture of the second course of Cantor Lectures, on "Solid and Liquid Illuminating Agents," was delivered by Mr. LEOPOLD FIELD, F.C.S., on Monday evening, March 5. The lecturer gave a description of ozokerit and other mineral sources of light, and concluded with a survey of the candle trade, and the various inventions and industries connected with it.

At the conclusion of the lecture, a cordial vote of thanks to Mr. Field was carried on the proposition of Professor Abel, F.R.S., Member of Council.

The lectures will be printed in the *Journal* during the summer recess.

INDIAN SECTION.

At the meeting of the Section held on Friday evening, March 2nd, the Hon. Sir ASHLEY EDEN, K.C.S.I., in the chair, a paper was read by Mr. W. S. SETON-KARR, on "Agriculture in Lower Bengal." A report of the meeting will appear in next week's *Journal*.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1883, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great service to Arts, Manufactures, and Commerce in the creation of the [illegible] country, the benefit of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, in the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially, by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, LL.D., F.R.S., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which, for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces

rendered by him in connection with economisation of fuel in its various applications to the Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy, and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S., "on account of the signal services rendered to Arts, Manufactures, and Commerce, by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science and industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the industrial arts by his investigations in organic chemistry, and for his successful labours in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silk worms and domestic animals, whereby the arts of wine-making, silk-production, and agriculture, have been greatly benefited."

The Council invite members of the Society to forward to the Secretary, on or before the 21st of April, the names of such men of high

Proceedings of the Society.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, February 22, 1883; Captain EYRE SHAW, C.B., in the chair.

The paper read was—

SOME CAUSES OF FIRE AND METHODS FOR THEIR PREVENTION.

BY WALTER G. MCMILLAN, F.C.S.

When honoured by an invitation to read a paper on this subject at a meeting of the Society of Arts, I could have wished that one with greater personal experience and authority than myself might have been found to undertake so important a task; yet the mere fact of your attention being called to the point in question, and the discussion which it is hoped may follow the paper—however feeble the latter may be—cannot but prove beneficial in directing public attention, for a moment, to the calm consideration of a matter generally discussed only in those terrible moments when newspapers are filled with exciting accounts of some awful catastrophe; then only do men awake from their slumber of fancied security, and bethink themselves, for a passing instant, of the imminent danger which is constantly threatening them; the excitement over, the desire for security passes away. So catastrophe follows catastrophe, and but little is done to prevent their repetition in the future. So, too, one by one, our ancient mansions—connecting links between the past and the present—are irreparably damaged or entirely destroyed; one by one these valuable illustrations are ruthlessly torn from the great book of history, where, with a little additional care, they might have been preserved to future generations as relics of a time long since past.

The range of matter included in this subject is so vast, that I could not hope, in the short space of one hour, to give even a complete synopsis of all that might be written concerning it. I must, therefore, confine myself to the consideration of points of greater importance, or of especial interest.

Let us first direct our attention for a short

combustion. It may be taken as a general rule that, when chemical combination occurs —that is, when two or more substances unite to form a new body having different properties to the original substances—heat is evolved; when the heat is so great that light also is produced, we say that combustion is taking place.

Here is an experiment, which I have arranged to manifest to you this quiet invisible heat of chemical combination. Two glass cylinders are taken, and in one of them is placed the bulb of an air thermometer, having a long stem passing through the bottom of the cylinder, and bent into the shape of a **U**; an insulated wire, connected with one pole of a voltaic battery with an electric bell in circuit, is passed to the bottom of the bend, which is then filled with mercury; the wire connected with the other terminal is arranged so that its extremity is a short distance above the level of the mercury in the tube. The cylinders being filled respectively with hydrochloric acid and ammonia gases, by inverting the one upon the other, these two invisible gases unite to form a dense opaque solid—ammonium chloride—and heat is evolved; this heat expands the air in the thermometer bulb, whereby the mercury is driven round the bend of the **U**-tube, making metallic connection between the poles of the battery, and causing the bell to ring. This experiment will serve as an illustration of the principle of certain electric fire-alarms to which allusion will be made presently. For our purposes to-night, combustion, or fire, may be defined as the chemical combination of bodies with oxygen gas, attended by light and heat; for although combustion may take place in other gases, it is only with atmospheric oxygen that we have to deal in treating of this subject.

All substances are combustible or incombustible, according as they are or are not capable of undergoing this rapid and violent combination with oxygen at the ordinary temperature. Different materials have different igniting points; that is, variable amounts of heat are required to raise them to the temperature at which they take fire. Let us suppose that, by some means, a small point on the surface of an oxidisable body is raised to its igniting point, chemical union with atmospheric oxygen takes place, and is attended by the evolution of heat; if the heat so produced be sufficient to raise the surrounding portions of the material to their igniting point, the action will be continued, and the substance will burn—it is combustible. If, on the other purpose, the action must cease with the removal of the source of heat—the body is incombustible. In the latter case, if additional heat be supplied from external sources, so that this heat, with that produced by the combustion, are together sufficient to raise the adjacent matter to the igniting point, the substance will burn.

Thus many bodies, incombustible under normal conditions, inflame readily at a higher temperature, and the rapidity with which combustible material burns is greater in proportion to the increase of temperature. The same will be obtained by increasing the intensity of combustion. Many bodies, therefore, incombustible in atmospheric air—which contains four volumes of the inert gas nitrogen to each volume of the active oxygen — will take fire readily when placed in an atmosphere of pure oxygen, and, under similar circumstances, combustible substances burn with increased violence.

From the foregoing remarks, it should be clear that failure in the supply of oxygen must be attended by extinction of flame; this end may be attained either by substituting for the oxygen an atmosphere of any gas which is incapable of supporting combustion, or by preventing all possibility of access of fresh supplies of air, so that the whole of the oxygen will be removed in combination with the material of the burning substance, and only the products of combustion and atmospheric nitrogen remain, neither of which is capable of continuing the action.

In short, any gas which will not support combustion must extinguish fire; and for this purpose inflammable gases, such as hydrogen or coal gas, are, under suitable conditions, as certain in their action as carbonic acid or nitrogen. This fact may be readily demonstrated by igniting wood-shavings in a glass bell jar covered with wire gauze, and passing into the latter a rapid stream of coal gas; combustion is immediately checked.

Flame may be extinguished by removal of heat. Just as by sufficiently increasing their temperature, many otherwise incombustible bodies might become combustible; so, by reduction of temperature, many highly inflammable substances may be rendered incapable of burning; thus, a piece of paper tightly stretched round a copper rod, may be held for a long time in the hot flame of a Bunsen's burner without showing any signs of charring,

not raised to its igniting point. If paper be similarly fastened to a cylinder of wood, which is a bad conductor of heat, nearly the whole of the available energy of the flame is accumulated in the paper, which thus ignites immediately.

We have, then, seen that as surely as the animal body must die if its proper supply of food be withheld, so must the flame of ordinary combustion cease to exist on the failure of a due proportion of oxygen; and, secondly, that flame will be extinguished if by any means its heat is withdrawn with sufficient rapidity. These points have a most important bearing upon the extinction of fire.

In dealing with a subject like the present, it is difficult to adjust mentally the relative danger of of fire from various causes, and to avoid laying too much or too little stress upon certain points which, perhaps, tend to confirm or to controvert some preconceived notion or pet theory. To obviate this, and to have some reliable data upon which to work, I have abstracted and tabulated some of the more important facts recorded by Captain Shaw in his Annual Reports to the Board of Works upon London fires. I considered that figures calculated upon the numbers for twelve years would be sufficient to yield a fair average, and had therefore taken the years from 1870 to 1881; while, however, these tables were in course of formation, the report for 1882 was published, and, in order to bring the matter up to date, I incorporated these figures in the tables, which represent, therefore, the thirteen years from 1870 to 1882 inclusive.

In this period there occurred 22,262 outbreaks of fire, of which only 2,233 (10 per cent.) attained serious proportions; in their extinction nearly 220 million gallons, or about one million tons, of water were employed. In Table I. (page 383) are arranged the names of the trades which were responsible for the greatest number of conflagrations, and the proportion of serious to slight fires.

The first three columns in this Table, although extremely interesting, must not by themselves be taken to represent the risk of fire occurring on any given premises, because we do not know the relative numbers of buildings utilised for these various occupations in the metropolitan area; otherwise private houses would appear as the most dangerous dwellings. This is distinctly absurd, as the large proportion of fires occurring in this "risk" is evidently due to the vast excess of private houses fourth column, from its very nature, gives figures which are comparable, *inter se;* it records the inflammability of the premises, or of the goods stored therein, by indicating the chances of a small outbreak of fire resulting in serious damage. This column, then, represents fairly the relative risks incurred by different trades. It will be seen that private houses here sink to their right position as the lowest of all, while (of the occupations classified) saw mills and furniture dealers head the list.

We will now observe the influence of times and seasons upon the number of fires. First, as to the monthly distribution. It might be reasonably expected that the per-centage of fires would be at the maximum either in winter, when artificial illuminants and heating agents are most largely in use, or in summer, when inflammable materials are dried by solar heat, and, therefore, more readily ignited; but this does not appear to be the case, at least in London, the difference in number of outbreaks in the various months being comparatively small and irregular. In agricultural districts, I believe that the months of July and August give the heaviest numbers, owing, probably, to the heating of hay-stacks, and to the desiccation of thatched roofs.

The distribution of fires over the hours of the day seem to be governed by a distinct and well-defined law. In Table II. (page 384) I have translated into picture form—so that the eye may grasp the whole mass of figures at one rapid glance—the numbers given for certain years; I should have liked to publish the diagrams for the intervening years, but I think those given will sufficiently indicate the point to which I wish to draw your attention.

The method of reading the Table should be apparent. To ascertain the total number of fires occurring at a given hour in any year, find the curve representing that year; and from the point where that curve cuts the vertical line corresponding to the given hour, draw a horizontal line to the side of the diagram; the figure opposite the termination of this horizontal line is the number of fires which occurred at the required hour during that year. Thus, for example, between the hours of 8 and 9 a.m., in the year 1833, there were 12 fires; between 6 and 7 p m., in 1881, there were 124; and so on.

One cannot, I think, fail to be interested in observing not only the symmetry of these curves, but the wonderful agreement of the general

maximum occurs between 8 and 9 p.m., a time when artificial illuminants are most in requisition, and by which goods left smouldering on the closing of factories and warehouses would be likely to make the danger known; thence the numbers fall somewhat rapidly to the minimum from 6 to 9 a.m., when the gradual rise to the maximum sets in.

In Table III. (page 385) are recorded the actual number of fires which resulted from certain common causes, and their per-centage of the aggregate for the thirteen years; that all

TABLE I.—SHOWING THE RELATIVE INFLAMMABILITY OF VARIOUS PREMISES (CALCULATED FROM REPORTS OF LONDON FIRES, 1870-82).

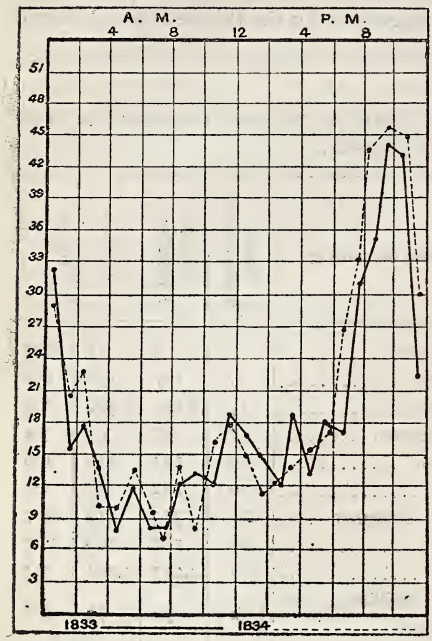
Premises occupied by	No. of Serious Fires.	No. of Slight Fires.	Total Fires.	Per-centage of Serious Fires.	Premises occupied by	No. of Serious Fires.	No. of Slight Fires.	Total Fires.	Per-centage of Serious Fires.
Bakers	12	240	252	4·8	Ironmongers	9	64	73	12·3
Beer-shop Keepers	19	158	177	10·7	Laundries	9	127	136	6·6
Booksellers & Stationers	18	217	235	7·7	Lodgings	35	2,525	2,560	1·4
Butchers	3	104	107	2·8	Marine Stores	7	87	94	7·4
Boot and Shoe Makers	24	323	347	7·0	Milliners	9	123	132	6·8
Brush Makers	19	70	89	21·3	Offices	6	182	188	3·2
Builders	77	216	293	26·3	Oil and Colourmen	85	325	410	20·7
Cabinet Makers	98	279	377	26·0	Printers	27	162	189	14·3
Carpenters	30	182	212	14·1	Private	107	4,257	4,364	2·4
Chandlers	17	147	164	10·4	Public Buildings, not Theatres	2	70	72	2·8
Cheesemongers	13	95	108	12·0					
Chemists	16	82	98	16·3	Rag Merchants	20	54	74	27·0
China, Glass, &c., Dealers	11	85	96	11·4	Railways	13	134	147	8·8
Churches	12	72	84	14·3	Refreshment Rooms	18	160	178	10·1
Coal and Coke Merchants	4	94	98	4·1	Saw Mills	25	47	72	34·7
Coffee Houses	19	289	308	6·2	Schools	9	89	98	9·2
Confectioners	16	130	146	11·0	Stables	43	269	312	13·8
Corn Dealers	35	147	182	19·2	Tailors	33	345	378	8·7
Drapers	41	326	367	11·2	Tinmen, Braziers, and Smiths	8	76	84	9·5
Engineers and Machinists	23	108	131	17·6					
Farming Stock	10	237	247	4·0	Tobacconists	20	223	243	8·2
Fishmongers	5	86	91	5·5	Under Repairs	38	250	288	13·2
Fried Fish Shops	7	72	79	8·8	Unoccupied	17	186	203	8·4
Furniture Dealers	49	116	165	29·7	Upholsterers	21	75	96	21·9
Furriers	9	65	74	12·2	Victuallers	61	694	755	8·1
Greengrocers, Fruiterers, &c.	27	236	263	10·3	Wardrobe Dealers	2	70	72	2·8
					Warehouses	6	80	86	7·0
Grocers	56	347	403	13·9	Watch and Clock Makers	14	61	75	18·7
Hairdressers	4	84	88	4·5	Wine & Spirit Merchants	9	125	134	6·7
Hatters	20	80	100	20·0	Other Trades	867	4,271	5,138	16·9
Hosiers	8	59	67	11·9					
Hotels	11	152	163	6·7	Total in 13 years	2,233	20,029	22,262	10·0

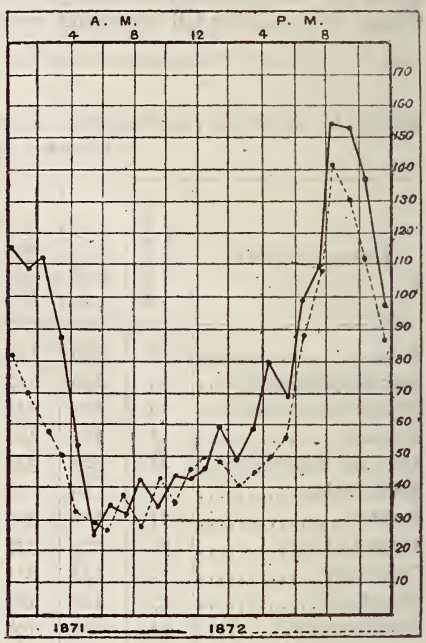
the more frequently recurring causes are here detailed is evident from the fact that only five per cent. of the total number of fires remain unenumerated.

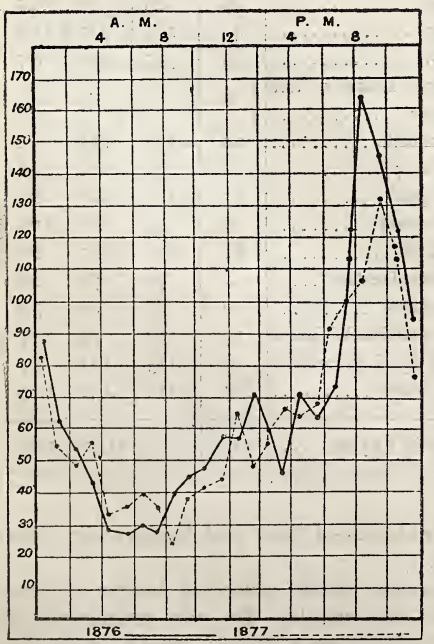
It will be observed that by far the greatest rather abuse—of light and heat-giving apparatus.

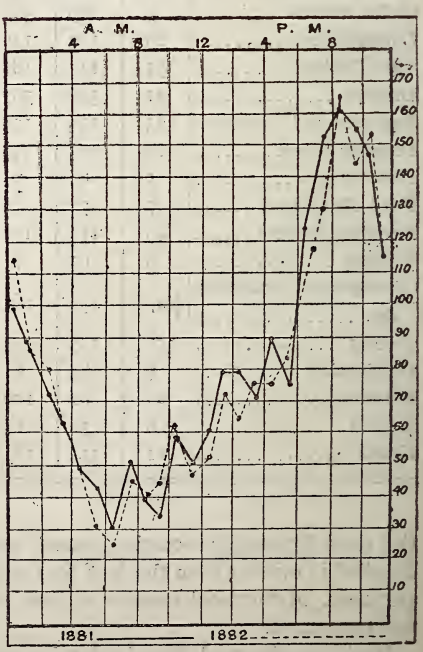
The most prolific source of danger appears to be the candle. By the retirement of the old-fashioned tallow candle, with its

TABLE II.—CURVES SHOWING THE NUMBER OF FIRES WHICH OCCURRED IN LONDON AT EACH HOUR OF THE DAY IN THE YEARS 1833-4, 1871-2, 1876-7, 1881-2.









favour of the modern snuffless candle, one great danger has been removed; but there still remains one far more important, and one which the candle possesses — though to a greater extent—in common with all portable illuminants; I refer to the fatal ease with which a naked flame may suddenly be placed in positions of extreme peril; for instance, immediately beneath a wooden shelf, or within a few inches of light window curtains or bed furniture. This is a difficulty easily surmounted by using tall glass shades reaching to a height of two or three inches above the top of a new candle; and surely such shades would, in the end, prove economical by protecting the flame from draughts of air, and so minimising the waste

Table III.—Showing Principal Causes of Fire, compiled from Reports of London Fires, 1870–82.

Cause.	No. of Fires.	Per cent.	Cause.	No. of Fires.	Per cent.
Airing linen	338	1·5	Hearth, fire on	33	·1
Boiler, overheat of	126	·5	Hearth, timber under	27	·1
Boiling over of fat, &c.	333	1·5	Hot ashes	595	2·6
Burning rubbish	59	·3	Incendiarism	79	·3
Candle	2,180	9·8	Intoxication	51	·2
Children playing with fire	326	1·4	Lamp, spirit	76	·3
Children playing with lucifers	450	2·0	Lamp, spirit, exploding	81	·4
Doubtful	153	·7	Lamp, spirit, upset	742	3·3
Fire, clothes in contact with	53	·2	Light thrown down	1,731	7·8
Fireworks	46	·2	Light thrown down area	38	·2
Flue blocked up	140	·6	Light thrown from street	251	1·1
Flue, defect in	922	4·1	Lime slaked by rain	61	·3
Flue adjoining, defect in	223	1·0	Lime slaking	99	·4
Flue foul	429	1·9	Lucifers	445	2·0
Flue adjoining, foul	77	·3	Oven, overheat of	69	·3
Flue, overheat of	120	·5	Pipe stove	57	·2
Flue adjoining, overheat of	43	·2	Plumbers at work	30	·1
Flue, copper, defect in	48	·2	Smoking tobacco	458	2·0
Flue, furnace, overheat of	28	·1	Spark from fire	1,990	8·9
Friction of machinery	33	·1	Spark from flue	55	·2
Fumigating	54	·2	Spark from forge	49	·2
Furnace, overheat of	89	·4	Spark from furnace	82	·4
Gas-bracket, swinging	365	1·6	Spark from lamp	40	·2
Gas, escape of	668	3·0	Spark from locomotive	87	·4
Gas, lighting	67	·3	Spontaneous ignition	199	·9
Gas, seeking escape of, with light	261	1·2	Stove, drying, overheat of	101	·4
			Stove, gas, overheat of	98	·4
Gasfitters at work	29	·1	Stove improperly set	170	·8
Gaslight	110	·5	Stove, overheat of	160	·7
Gaslight, curtains or blinds in contact with	109	·5	Vapour of spirit, &c., in contact with flame	155	·7
Gaslight, goods in contact with	222	1·0	Unknown	4,784	21·5
Gaslight, goods too near	41	·2	Other causes	1,109	5·0
Gaslight, overheat of	34	·1			
Hearth, defect in	84	·4	Total in 13 years	22,262	99·0

Of lamps, those fed by colza and such oils are, perhaps, the safest, though less convenient and more expensive. Now, however, these, and even gas, are giving way before mineral oil (petroleum, paraffin, or crystal oil,

Petroleum is, with due precautions, a very safe illuminant; benzoline and other spirits are extremely dangerous. Petroleum will not ignite at ordinary temperatures—indeed, a lighted match is extinguished if plunged into the liquid—it may be burnt in ordinary lamps. Benzoline is highly inflammable, and at common temperatures gives off abundance of vapour, which ignites readily at some distance from the reservoir of spirit, and may convey the flame to the liquid with disastrous consequences; it must be burnt only in lamps of special construction. The benzoline lamp is arranged so that the spirit is entirely absorbed by means of sponge, and care must be taken to drain out the excess liquid; otherwise, if an explosion occur—as frequently happens—owing to the formation of a mixture of air and vapour, blazing spirit will be scattered far and near. Vessels containing benzoline must never be opened near a flame; indeed, it would be well if this dangerous substance were never used at all.

I said that, with due precautions, petroleum was fairly safe; this qualification was necessary, because, in the first place, a cheap and impure variety of the oil is sold, which retains a certain quantity of the more volatile bodies occurring in natural crude petroleum; such a sample will frequently burn on the simple application of a flame, and will invariably do so at a slightly elevated temperature; secondly, owing to the common use of both liquids, benzoline may become mixed with, or even substituted for petroleum. I should recommend consumers to buy petroleum in quantities of not less than a gallon at a time, and have each sample tested at the time of purchase; this simple expedient would obviate all chance of mistake.

The simplest possible test is, to pour into a saucer a little of the oil to be examined, and then apply a lighted match to the surface of the liquid; the latter should not burn, but should even extinguish the flame of the lucifer. This test, though simple, is not sufficiently delicate to be strictly reliable; it is far safer to apply the "flash test" in all cases.

When petroleum is gradually heated, it gives off vapour, which, at a certain point—constant for each individual sample, but varying with different specimens—will be in sufficient quantity to give, when mixed with air, a very slight explosion or flash upon the approach of a light, and will take fire at a temperature sample must never be below * 100° on Fahrenheit's scale, nor the igniting point below 120°.

Here let me describe an apparatus by which, with very little skill, any person may be able to ascertain approximately for themselves the flashing-point of a sample of petroleum. There cannot be claimed for it great accuracy, nor, indeed, novelty, for it is but a modification of the old "open-test;" but it is inexpensive, and may be made from common materials in a short space of time. A common saucepan (holding about a quart or over), a small coffee-cup or measuring glass, a piece of sheet metal or of cardboard, some stout wire, and a thermometer, are all that is required for its construction. A piece of the metal (or card) is cut into a circular shape, so that it just fits into the saucepan, and is, therein, suspended from the sides by small wire hooks; in the centre of this disc is cut out another circular hole, into which fits the cup or glass. Another piece of metal is now cut, having a length nearly equal to the circumference of the saucepan, and a height of about four or five inches; this is bent round, and fitted into the saucepan, so as to increase the height of the latter, and thus form a screen to protect the arrangement from air currents. A piece of bent wire can be fastened to this screen, and be made to support a thermometer, so that the bulb of the latter is in the centre of the cup without touching the bottom or sides. To apply the test, fit up the apparatus as described, pour water into the saucepan until the level has reached the suspended disc; pour the petroleum carefully into the cup until about two-thirds full, and heat the water in the saucepan by means of a spirit lamp. The temperature of the water must rise very gradually—about 2° Fahr. to the minute. When the thermometer in the oil indicates a temperature of 90° Fahr., apply, momentarily, a lighted taper to within half an inch of the liquid in the cup; repeat this performance at each rise of one degree indicated on the thermometer scale, until a sudden pale blue flash of flame hovers over the surface of the liquid, and is instantly extinguished; read off the temperature—this is the flashing point. To determine the igniting point, continue the application of heat until the liquid no longer flashes only, but burns with a steady flame. The temperature of the flashing point should be over 100°, of the igniting point, 120°.

* By Professor Abel's recent improved "close-test" for ascertaining the flashing point, the limit of safety is 73° Fahr.,

I must again urge that this is only a rough-and-ready qualitative method, and should suggest that, before using it, a sample of oil of known flashing point should be obtained. Let this be tested by the crude apparatus until fairly constant results are obtained, and so the conditions most favourable to accuracy arrived at. The cup must always be filled to the same extent with petroleum, and all conditions must be the same for each test.

Coal-gas, by the extreme facility of its adaptation to all circumstances, necessarily occupies a very prominent position among illuminants, and, with suitable fittings and due care, is a very safe light-producer. Unfortunately, its gaseous nature, the very quality which renders it so convenient, is also a great source of danger, for a slight leak, such as may readily occur in modern fittings, soon allows a large volume of gas to escape, and thus to become mixed with air; if the mixture should happen to lie between the proportions of ten and five of air to one of gas, it will be more or less violently explosive upon the approach of flame. Hence the extreme folly of searching with a light for a suspected escape; although there may not be sufficient coal-gas in a room to form an explosive mixture, it must be borne in mind that such a mixture may be present in confined spaces near to the source of leakage, such as a cupboard, or between the floor and ceiling. It would be well to note here that gas is not of itself explosive; it requires to be mixed with a certain proportion of oxygen gas, for the explosion is simply a case of rapid chemical combination between the inflammable constituents of the gas and the atmospheric oxygen; indeed you will remember that I showed that coal gas would actually extinguish fire. I might here remark that many substances in a state of fine division, such as flour or coal dust, have the property of exploding and carrying flame, when mixed with the right quantity of oxygen or air.

Upon the question as to the expediency of turning off the gas at the main before retiring for the night, opinions are divided. As a general rule, I am inclined to advocate that it should not be turned off; but the arguments for and against so doing are so evenly balanced, that little is required to turn the scale in either direction. In forming an opinion, one must be governed by the particular circumstances of each individual case.

If some responsible person can have access that he may see that every gas-cock is closed, I should recommend that the gas be shut off from the main, so that, in case of fire, the gas-pipes may fuse, without at once increasing the body of flame by the gas supplied through them. If he cannot have such access—and it is rarely that he can, owing to many of the rooms being used as sleeping apartments—I should urge that the supply of gas be not cut off, because no gas would be left burning in such rooms as are under his supervision, and there would thus be no chance that a draught of air might extinguish a jet, and allow the gas to escape, or impel light inflammable material into contact with it; while, in bedrooms, if the occupant neglect to extinguish his burner—as may well be with those who practice the most dangerous habit of reading in bed—the gas may remain harmlessly burning; where, had it been turned off at the meter at night, a deadly stream of poisonous coal-gas would be urged into the room through the open cock on the following morning; the sleeper may thus be easily suffocated, if he be already not scorched by an explosion.

Before concluding our remarks upon gas, allusion must be made to the danger of swinging gas-brackets; all movable brackets are dangerous, and I wish here to call attention to the fashion adopted in many suburban villas, of placing elbow gas-brackets between the windows of the principal bedrooms, or in dangerous proximity to highly inflammable curtains and blinds.

Again, it has often astonished me that fires do not more frequently occur in the shop-windows of drapers' establishments, where lamps appear to be arranged in a most haphazard and careless way, in the midst of a light combustible stock.

From the light giver, we naturally turn to the light producer. The old friction lucifer is being superseded by the so-called safety matches, and in so far as this class cannot be ignited by friction upon other surfaces, they are safer; but some particular varieties of these must be considered highly dangerous, as, in striking them upon the prepared surface, lighted pieces of the match-head composition fly off, and fall unnoticed in the dazzling brilliance of the sudden light. I myself know of instances of fires originating from such pieces falling upon window curtains. The remedy is to use only tried and approved brands. It is a common habit, especially among smokers, and one which calls for

and burning material before the flame is completely extinguished. Reference to Table III (p. 385) will show that a large number of fires have been traced to this cause.

I wish here to introduce to your notice a recent invention, which, by superseding matches for lighting gas jets, is calculated to lessen the risk of fire from this cause. The instrument is known as "Clarke's Patent Gas-light," and by the kindness of the General Electric Apparatus Company, of Aldermanbury, to whom the patent now belongs, I am able to show you one of them. In construction it is equally ingenious and simple, consisting merely of an ebonite handle some eight inches long, which contains a small galvanic battery and induction coil; attached to this handle are two wires, separated at their points by a small piece of glass, and suitably protected from injury; on pressing a button in the handle, connection is made between the battery and coil, and a series of minute sparks passes between the points of the wires, and by these the gas is easily ignitible.

Directly and indirectly, artificial heating must be accounted responsible for a large proportion of fires. With the common open-hearth system of heating, the chief danger appears to lie in sparks being projected from grates unprotected by wire guards; a difficulty which, obviously, is easily overcome. In connection with the open fire must be taken the flue. The peculiar diseases to which chimneys are liable will be evident after a glance at Table III; the remedy must in each case suggest itself at once.

Many, perhaps most, of the fires which occur in old mansions can be traced to a defective system of construction, by which wooden beams were either built into the brick wall of the chimney, or even in many cases across the flue itself; such beams would become desiccated and converted into touchwood, and thus liable to ignition by a very small spark; they would then smoulder, may be, for many days, until at last, having burnt through the thickness of the wall, the fire communicates to wooden wainscotting or panelling, and in a short time the whole building is a heap of ruins. Close stoves, hot-air and steam-pipes, &c., owe their dangerous properties principally to their aptitude for becoming overheated, and thus drying, and finally igniting, combustible material in their immediate vicinity.

It would be impossible to over-estimate the importance of impressing upon servants the hot ashes or fuel; an instance of a fire caused by carelessness in this matter came under my notice but a short time ago; a servant attempted to carry live coals in a common tin dust-pan, with the result that the solder which held together the parts of the pan melted, and the coals fell upon inflammable material, with what result it is needless to inquire.

Before leaving this subject, I wish to enter a protest against the present dangerous custom of decorating fire-places or mantel-boards with curtains and hangings of a combustible nature; such a practice has frequently imperilled the houses so fitted.

Few more causes of fire now remain for discussion.

Quicklime, as used by builders, is more or less pure anhydrous oxide of calcium. When water is thrown upon this compound chemical combination takes place (with formation of hydrated oxide of calcium, or slaked lime), and a large amount of heat is generated; this heat so produced is, if considerable quantities of lime be slaked at once, sufficient to raise the temperature of many bodies to the igniting point. Slaking of lime may be intentional, as in the ordinary practice of the builder, or accidental, as by an overflow of the tide or by a heavy downfall of rain. Quicklime should, therefore, never be stored where water can by any possibility have access.

Hitherto, in dealing with chemical action as a cause of fire, we have considered only the rapid oxidation of substances; but the same amount of heat is given out by the union of any one substance with another body, whether it be instantaneous or very gradual in its nature; if, in the latter case, the heat can be stored, it will, after a time, become sensible. A haystack, or stores of coal, wool, &c., may thus, by slow chemical action, and by the accumulation of all heat so produced, at last attain the temperature at which they take fire, and thus we have instances of so-called spontaneous ignition. Mr. Bolas, in his interesting paper on the "Fire Risks incidental to Electric Lighting" last year, pointed out that cotton waste or rags saturated with oil would, under suitable conditions, be subject to spontaneous combustion.

Before leaving this subject, I must emphatically remind you of the dangerous property of liability to spontaneous combustion possessed by red-fire compositions. Many fires at theatres, which have, for lack of sufficient

have probably thus originated. Mr. John Spiller informs me that he was an eye-witness of the spontaneous ignition of this material at the Royal Arsenal, Woolwich, on the night of the 8th March, 1861, which resulted in the destruction of a small quantity in store at the time. The greatest possible care is there taken that these compositions may not be stored with any explosives; and it would certainly be advisable that similar precautions should be taken wherever it is kept in quantity.

There are but two causes of fire to which I shall now allude; they have not been very productive as yet in occasioning conflagrations, but are yet well worthy of note.

Plumbers, by carelessness in the management of the fires which they use upon the roofs of buildings under repair, have been the means of destroying many valuable buildings. An apparatus has been devised by Mr. Penrose, the architect to St. Paul's Cathedral, and Messrs. Shand, Mason & Co., by which these fires are shielded, and the danger obviated. It consists simply of a wrought iron case, so arranged that the fire will burn freely, and the workman have ample room for manipulating his tools; to ensure safety, it is filled to a depth of several inches with water, so that falling cinders and fuel are immediately cooled and rendered harmless. Might not the use of some such arrangement be enforced for all buildings of national interest and importance?

Finally, the rays of the sun, when concentrated by means of a lens, are sufficient to ignite inflammable materials; indeed, it may be remembered by those who attended the late Electrical Exhibition at the Crystal Palace, that a method was there exhibited for registering the hours of actual daily sunshine, by collecting the rays with a glass ball, and causing them to be focussed upon a strip of paper; in this way, while the rays fell upon the glass, a hole was burnt in the paper, and so an automatic record was made. In this way, fires have originated from the collecting of the rays by means of lenses, defects (eyes) in window glass, and even by water-bottles standing upon tables in front of windows.

In a London museum, some years ago, the rays of the early morning sun, after passing through two thicknesses of glass, fell upon a lens, which happened to be at exactly its correct focal distance from the wooden partition of the case, which was consequently charred; and, indeed, the small black mark of burnt wood is visible to this day. It is well to remark that the museum narrowly escaped destruction.

In Table IV. (page 390) I have collected the numbers of fires resulting from the most frequently recurring causes which took place upon certain premises, and in order that they should be strictly comparable, I have calculated the per-centage of causes for each trade.

Thus—15·7 per cent. of the fires at private houses were caused by candles; 27·8 per cent. of those at drapers were due to goods coming in contact with gaslight, and so on. Some points in this Table will, I think, repay a little attention.

I must now deal shortly with a few of the plans which have been suggested for the prevention of large fires, by extinguishing them before they have reached serious proportions, and this subject is quite as important as that of the actual direct cause of the fire; for it must be remembered that a few pints of water at the outbreak of the fire are equal to many hundred of gallons at a later stage.

From the few words I said about the conditions necessary to the spread of fire, it will be understood that any method by which the supply of air to the flame can be cut off, or by which sufficient heat can be absorbed from the burning material, will suffice to extinguish the fire.

The numerous substances proposed as extinguishing agents (*e.g.*, water, steam, carbonic and sulphurous acids, sand, ammonia, &c.), depend for success upon one or both of these qualifications. The two last-named have been suggested for grappling with benzoline and spirit fires; sand answers admirably, and a bucket full of this material is probably of greater use for this purpose than an equal volume of water; spirit is lighter than water, and therefore the application of the latter serves only to float the burning benzoline over a greater surface, and so to increase the spreading of the fire.

It has been suggested that, where benzoline is stored in any quantity, upon each cask should be placed a bottle containing strong ammonia solution; on the ignition of the spirit, these bottles would burst by the heat, and fill the chamber with an atmosphere of ammonia gas. It is perfectly true that benzoline could not burn under these conditions, but it is questionable whether, by the means proposed, it would be possible to obtain such an atmosphere; the immense body of flame produced by a fire from one or two casks of spirit

BLE IV.—ILLUSTRATING COMPARATIVE RISKS OF VARIOUS PREMISES, AS SHOWN BY THE PER-CENTAGES OF FIRES ARISING FROM CERTAIN COMMON CAUSES (CALCULATED FROM THE ANNUAL REPORTS FROM 1870 TO 1882 INCLUSIVE).

CAUSE.	OCCUPATIONS.																									
	Bakers.	Beer-shop keepers.	Booksellers, Stationers, &c.	Boot & Shoe Makers.	Builders.	Cabinet Makers.	Carpenters.	Coffee Houses.	Corn Dealers.	Drapers.	Farming Stock.	Green-grocers.	Grocers.	Hotels.	Lodgings.	Offices.	Oil and Colourmen.	Printers.	Private.	Refreshment Rooms.	Stables.	Tailors.	Tobacco-nists.	Under Repairs.	Victuallers.
ing linen	·4	...	·8	·6	·3	...	·5	2·2	1·6	1·3	...	1·9	1·2	...	3·1	...	...	...	3·3	·6	...	·8	·4	...	1·0
ling over, fat, &c.	...	1·7	·4	1·1	1·0	·5	·5	·3	·5	...	...	·4	1·2	1·8	·2	...	1·0	·5	1·1	2·8	1·3	·8	...	3·5	1·2
ning rubbish	...	...	·4	...	2·0	...	...	...	·5	...	4	...	...	...	·2	·5	·2	...	·2	...	...	...	...	1·4	·4
idle	12·7	13·5	8·5	9·5	2·7	2·6	5·2	15·3	7·2	5·7	·7	14·1	13·4	9·6	19·6	4·7	7·8	3·2	15·7	6·7	15·7	8·2	6·2	3·1	7·9
ldren playing with fire	...	1·7	...	...	1·4	·3	1·4	·3	·5	...	2·9	·4	·3	·6	5·7	...	...	...	2·1	...	1·0	...	...	1·7	·3
ldren playing with lucifers	1·6	·6	1·7	·6	1·7	1·3	5·6	1·9	1·1	·3	7·7	·8	1·0	...	4·3	2·1	·8	1·0	3·6	...	1·6	1·3	·4	·7	·8
e, blocked	...	·6	·8	·6	...	·3	·5	1·9	1·1	·3	...	1·1	1·5	·6	·4	1·0	·2	1·6	·5	·6	·3	·5	1·2	...	1·8
e, defective	4·8	5·1	2·9	2·6	1·7	1·3	·9	8·7	1·1	1·9	...	2·7	2·0	22·6	3·6	9·0	·2	4·7	7·6	7·3	1·0	4·7	2·0	1·4	7·3
e, foul	2·4	1·7	·4	1·1	1·0	1·0	...	5·5	...	·3	...	1·1	2·2	8·0	2·9	3·7	·5	..	3·5	5·6	·3	2·1	·4	·7	3·3
e, overheat	·8	...	·4	...	·3	...	...	·6	...	...	·4	...	...	·6	·2	2·1	...	...	·6	4·5	·3	·3	...	...	1·0
nigating	·4	...	...	·3	...	...	...	...	...	...	·4	...	·5	..	·5	...	...	...	·5	...	...	·5	·4	...	·3
s bracket, swinging	1·2	·6	3·8	2·9	·7	...	...	1·0	·5	8·2	...	2·3	2·7	...	·5	·5	1·7	1·0	2·5	2·2	1·6	3·9	·8	...	2·2
s, escape of	2·8	5·6	2·2	8·9	1·7	1·3	·9	6·2	·5	3·8	...	2·7	2·5	7·3	·5	6·3	2·2	4·7	2·9	3·3	·6	5·5	7·0	4·6	8·3
s, seeking escape with light	1·6	2·8	1·3	1·7	1·0	·3	·5	·6	·5	1·1	...	·8	1·5	3·7	·4	3·1	·2	...	1·7	...	·3	2·4	·4	·3	2·8
s, lighting	·4	...	·4	·3	...	...	...	...	...	4·4	...	...	...	·6	...	·5	·2	...	·4	...	·3	...	·4	...	·1
slight	...	2·3	·4	1·7	1·0	·5	...	...	...	1·1	...	1·1	·7	...	...	·5	1·9	...	·1	1·1	1·0	·5	4·1	·3	1·3
slight, curtains in contact with	·4	1·1	·4	·6	...	...	...	1·6	·5	1·1	...	...	·3	·6	·1	...	...	...	1·1	...	...	·5	·4	...	·6
slight, goods in contact with	...	...	5·5	·8	·3	...	...	·3	...	27·8	...	·4	·5	...	...	...	3·7	...	...	1·1	...	3·9	2·9	...	...
t ashes	4·4	·6	4·3	2·0	2·7	1·3	2·3	4·2	...	1·1	...	·8	1·0	3·1	1·2	9·0	·8	6·3	2·4	2·8	1·6	·8	·4	2·4	1·8
endiarism	...	...	...	·3	1·7	...	·5	·3	...	...	7·3	...	...	...	·2	...	...	...	·2	...	·3	...	...	1·4	·5
oxication	...	...	...	...	...	...	·5	...	...	...	...	·4	...	...	1·3	...	...	...	·2	...	...	...	...	...	·1
np spirit, exploding	...	...	...	·3	...	...	·5	...	...	...	...	...	·5	...	1·3	...	·5	...	·7	...	...	·3	...	...	·1
np spirit, upsetting	·4	2·3	·8	3·2	·7	1·5	·9	1·0	·5	1·6	...	3·8	1·0	·6	11·9	·5	6·1	...	5·9	...	·3	3·1	2·5	·7	1·0
ht thrown down	12·3	10·2	14·9	10·9	3·4	8·2	14·1	5·5	13·7	6·0	30·4	8·4	9·9	6·1	2·8	15·4	9·5	16·4	3·0	9·0	8·0	7·4	19·8	4·6	13·7
ht thrown from street	1·6	·6	3·8	1·1	·7	1·0	4·2	...	14·8	·8	...	2·3	1·0	...	·1	2·6	1·0	3·2	·1	·6	5·7	2·4	2·0	2·1	·2
ne slaking	...	...	...	...	3·4	...	...	...	...	...	...	...	·3	...	...	1·0	·5	...	...	...	·3	...	...	16·1	·1
cifers	1·6	1·7	·4	2·2	·3	·3	·9	1·9	...	1·1	·4	·8	9·4	1·8	1·9	1·6	11·4	1·0	2·1	...	2·9	1·8	3·3	·7	1·6
oking tobacco	2·0	5·1	·4	3·2	2·4	2·4	·5	1·3	4·4	·3	2·2	1·5	1·2	1·2	2·8	1·0	·5	1·0	1·3	1·1	5·8	2·1	2·0	4·6	4·9
rk from fire	7·9	8·5	8·1	10·1	15·0	26·5	16·5	7·8	4·4	2·2	...	9·9	3·2	3·2	18·2	3·7	1·5	6·3	10·2	4·6	1·6	5·3	2·5	10·1	3·0
ntaneous ignition	...	...	...	...	·3	·3	·5	...	...	...	3·3	...	...	·6	...	·5	1·5	1·6	·1	...	·6	...	...	...	...
ve	·4	...	1·7	1·1	1·0	·8	·5	1·6	...	1·6	·4	·4	·3	1·8	·6	3·1	·5	...	2·9	8·4	...	·5	·8	·7	3·3
pour of spirits, &c., in contact with flame	·4	·6	·4	...	1·0	·3	...	·3	...	...	...	...	1·5	...	...	...	10·0	1·0	...	...	...	...	...	·3	2·9
known	11·1	27·2	25·9	25·3	36·2	40·6	32·1	16·5	35·2	22·3	29·6	30·8	32·9	9·8	6·9	14·3	31·9	33·3	10·7	18·5	35·5	29·3	29·4	13·3	16·0
ner causes	28·4	5·9	9·0	7·0	14·4	7·4	10·0	13·2	11·4	5·7	13·9	11·1	6·3	15·8	8·6	13·3	3·7	13·2	12·8	19·2	12·1	11·1	10·3	25·3	10·2
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0

enormous quantity of ammonia gas would be required to prevent admixture of air. Again, if the ammonia did not extinguish the flame, it would probably be decomposed by the heat into a mixture of one part of nitrogen and three of the inflammable hydrogen; and the latter, by burning when in presence of a full supply of oxygen, must increase the volume of flame, and assist the spreading of the fire to rooms above.

Sulphurous and carbonic acids have both been suggested as a means of solving this difficult problem of fire extinction; the latter, by pumping its solution in water upon the fire; the former, in the case of chimney fires, by burning sulphur or carbon bisulphide in the grate beneath the blazing flue.

Complete systems have been devised in factories and warehouses for the extinction of conflagrations by means of steam; but, of course, to be of any service, a large supply of steam must be ready for use at a moment's notice, at all hours of the day and night; and unless pressure were required unintermittently for use in the factory, the charges for firing, and the wages of an attendant to see to the boiler, would be a heavier fire-tax than most manufacturers would care to pay.

On the whole, nothing has yet been found to take the place of water. It is cheap, and—in towns with constant service supply—abundant. It is efficacious, because, when thrown on in its liquid state, it excludes the air for the time being; by its high specific heat (*i.e.*, the quantity of heat required to raise a given weight through a certain number of degrees of temperature), and latent heat (the amount of heat absorbed in converting boiling water into steam), it takes away much heat from the burning substance; and again, the steam resulting from its evaporation will not support combustion, and so, by excluding atmospheric oxygen, assists in this way in quenching the fire.

At this point, I wish to depart a little from my exact title, and draw your attention to the action of a small quantity of water thrown on to a blazing mass. When steam is led over red-hot carbon, the latter takes away the oxygen from the hydrogen, with which it is combined in steam, to form a new gaseous compound, oxide of carbon, leaving the hydrogen free; similarly, carbonic acid, in passing over red-hot carbon, combines with it to form another oxide of carbon, which is inflammable. Upon this principle depends may remember that Mr. Dowson, in a paper read before this Society last session, described "Dowson Gas" as being prepared by passing a mixture of air and super-heated steam over red-hot anthracite coal.

In endeavouring, then, to extinguish large conflagrations with a small quantity of water, the amount of heat absorbed in converting the water into steam is more than compensated for by that produced through the combustion of so vast a mass of material in the excess of atmospheric oxygen, and the only visible effect will be an increase in the volume of flame, owing to the combustion of the hydrogen and carbonic oxide when in contact with a full supply of oxygen; in fact, the burning building is converted into a gigantic gas-producer, in which steam and air (or carbonic acid) are being passed over the red-hot carbon in the upper floors of the building.

Many methods are available for throwing water upon fires, and each has its respective merits; of buckets I need not speak—hand-pumps or "Extincteurs" are to be preferred. The hand-pump is simply a small fire-engine or syringe, which is worked by hand in a pail capable of holding a few gallons of water, and will throw a steady stream of water with considerable force to a distance of from forty to sixty feet; they may be made of any size, provided only that they are portable. Such are the London Brigade Pump, and the more powerful Tozer Pump (having a larger air-chamber), of which specimens have been kindly lent for exhibition by Messrs. Merryweather and Co. To Messrs. Shand, Mason and Co. I am indebted for some samples. The large "corridor pump" on wheels is intended for use in hotels and other large buildings; the smaller pumps are of new design, and are of great power.

The "Extincteur" is simply a fire-engine in which chemical action takes the place of manual exertion; the energy is obtained by the decomposition of a carbonate by means of an acid. If an acid, such as oil of vitriol, be poured upon a solution of carbonate of soda, violent effervescence takes place, because the latter consists of carbonic acid gas combined with oxide of sodium; and so, when a stronger acid, such as oil of vitriol, acts upon this, it combines with the oxide of sodium to form a new substance, sulphate of soda, and the whole of the carbonic acid is set free, and as this latter is a gas, it is disengaged with violent effervescence. If this action be brought

generated will accumulate with ever-increasing pressure, until either the containing vessel gives way, or some means of escape is opened for the pent-up gas. In the "Extincteur," a strong and tightly closed metal vessel is nearly filled with a solution of carbonate of soda in water, and a quanity of acid is kept in a stoppered bottle in the midst of the soda solution ; to the bottom of the vessel is fixed a metal tube, to which a flexible tube, provided with a nozzle, is connected.

When required for use, the bottle of acid is broken, action immediately sets in, and pressure of carbonic acid gas is instantly obtained; on opening now the tap of the nozzle, a means of release is provided for the stored up energy, with the effect that the liquid contents of the "Extincteur" are forced out of the jet in a powerful stream, until no liquid remains in the vessel. It is, in fact, simply a large gazogene or seltzogene.

In Merryweather's "Extincteur," the acid is kept in a bottle with a loose-fitting stopper, the carbonate of soda is stored as usual; to prepare for use, it requires only to be inverted, the loose stopper thus falls from the bottle, allowing the acid to escape into the soda solution. In this machine, there is no chance of the nozzle becoming blocked at a critical moment by pieces of broken glass, because the acid-containing bottle is not broken at all; again, there is no opportunity for the water to leak gradually from the siphon tube and nozzle, because, until required for use, this joint is above the level of the liquid; it is not until the instrument is inverted that the pipe can leak in this way, and then a slight leak is of little consequence, because the "Extincteur" is intended for immediate service.

Messrs. Shand, Mason, and Co.'s "Extincteur" is somewhat similar to the last, but the acid is kept in a thin, tightly-stoppered bottle. By inverting the apparatus, a heavy leaden weight is caused to fall upon and break the acid bottle; adequate provision is here made for straining off pieces of broken glass, and a special ingenious construction of the tap excludes all possibility of blockage by glass, or by dirt from the water used. It enjoys the same advantages as Merryweather's with regard to the principle of inversion; neither of them require the services of a mallet or tool, which might be mislaid at a critical moment.

It would be difficult to give preference either to hand-pumps or "Extincteurs" for actual stances in which either could be used where the other would be useless.

The "Extincteur" is more portable, it may be carried upon the back, and so greater facility is afforded for "getting round the fire," and playing upon it from all sides, and only one hand is required to work it; but the liquid thrown contains in solution either a salt or a salt and an acid (according as the soda or the acid are in excess) which would be left upon the goods after the evaporation of the water.

The hand-pump is more easily charged, for one person may be employed in filling up the reservoir, while another works the handle; thus a continuous stream may be obtained for any time, but it cannot be used while being moved from one place to another, and, moreover, it requires two hands to work it; the water thrown is, however, uncontaminated with salt.

Little, if any, reliance is, I think, to be placed upon any benefit to be derived from the extinguishing properties of the carbonic acid dissolved in the water thrown from the "Extincteur."

But, after all, it is better to prevent outbreaks of fire than to be ready to extinguish them when they occur, and I wish now to devote a few minutes to the fire-proofing of combustible materials.

Messrs. Dennett and Ingle, whose system is so well known, and has been so frequently tested with eminently favourable results, have kindly lent me specimens of their composition. The material used is common gypsum highly calcined—as described by Mr. Bolas, in his course of Cantor Lectures on the calcium compounds. The concrete formed from this will sustain a heavy load, and is structurally strong; and, in addition, has the advantage of being proof against long-continued and intense heat. It is used for floors, and—protected by asphalte—for roofs. Its power of resisting, and low conductivity for heat, renders it an excellent casing for cast-iron columns, which, as is well known, are much weakened at high temperatures; and, similarly, wooden partitions or walls may be protected from fire by a half-inch thickness of this cement.

Asbestos paint is another invention which promises to be of very great service in lessening the risk by fire. A coating of this paint will greatly prolong the time necessary to ignite wood, and provided that the film of paint do not scale off, will, by preventing access of air, hinder the burning of the wood.

would be the destructive distillation of the wood.

The organic matter of the fibre would, by the action of heat without access of air, be submitted to a process of distillation, by which a quantity of inflammable gas is given off, and a mass of charcoal is left retaining the shape of the original wood; the gas must, of course, escape by cracking the coating of paint, and so add fuel to the already raging fire. It appears then that the great advantages to be derived from the use of this paint, are twofold. First, the inflammability of wood or material painted is reduced almost to a vanishing point. Let us suppose, for instance, that a candle or gas-burner be left burning immediately beneath a beam of protected wood; the heat, after the lapse of such time as is required for it to penetrate the paint, would decompose the wood at that point, and the evolved gas, after cracking the film, would burn as at a jet; but there the action must cease (unless light inflammable material be close at hand, and this would have been ignited first by the candle), because the heat produced by the combustion of the wood would not be sufficient to carry on the process of distillation of fresh portions of wood, protected as they are by a jacket of the paint. Secondly, even though exposed to the full fury of a large fire, the protected material could contribute to the general conflagration only such gas as might be evolved from itself, and the heat of combustion of the residual charcoal would be spared. When the external heat is removed, the painted wood is at once extinguished; it cannot smoulder, because oxygen cannot reach it.

Most successful trials of this substance have been made at the Crystal Palace, and on waste ground near the Thames Embankment; wooden erections in the form of miniature theatres were built—one was painted with ordinary paint, the other with asbestos. After filling both with combustible material soaked in petroleum, &c., and setting fire to them, it was found that the former became reduced in a short time to a heap of ashes, while the latter retained its shape perfectly.

Wood and other organic fibres may be rendered uninflammable by filling the pores of the substance with incombustible materials. The action of these may be of two classes: either the fibre is coated with a bad conductor of heat, similar to asbestos paint, or the impregnating substance is capable of volatilisation; so that all heat applied to the protected material is employed, first, in raising the added substance to its vaporising point, at which temperature the mass will remain constant until the bulk of the impregnation has been driven off as gas. As examples of the first class, may be cited tungstate and silicate of soda, and of the second, the salts of ammonia.

Among the many substances proposed are, in the first class, in addition to those already named, chloride of barium, chloride of zinc (for timber), alum, chloride of magnesium.

Mixtures may of course be made, containing bodies belonging to both groups, thus—and these proportions give, in practice, most excellent results. Martini uses:—

	For light tissues.	For painted scenes, timber, &c.	For cloths, ropes, straw, &c.
	Parts by weight.	Parts by weight.	Parts by weight.
Sulphate of ammonia	8	..	..
Carbonate ,,	2½	..	..
Chloride ,,	..	15	15
Boracic acid	3	5	6
Starch, dextrine, or gelatine	2	1	..
Glue	..	50	..
Borax	..	..	3
Water	100	100	100

An ingenious method of filling all the pores of wood has sometimes been adopted. It consists in saturating the wood with solutions of two or more substances, which, when mixed together, undergo double decomposition, with production of an insoluble compound, which is thus precipitated in the very midst of the fibre. Thus, by soaking the material first in a solution of sulphide of calcium, and then in protosulphate of iron, two insoluble substances are at once formed—sulphide of iron and sulphate of lime (Delfosse); similarly, dipping in chloride of magnesium and phosphate of ammonia—yielding phosphate of magnesia and chloride of ammonium—has been suggested.

In order that fires may be extinguished with the least possible damage to property, it is obvious that timely warning should be received of an outbreak; and here must be mentioned a device by which abnormal heat automatically records itself. The instrument is extremely simple, and is known as the electric thermo-

adapted to air thermometers, in which the expansion of air in a closed vessel forces mercury round the bend of a U-tube, and so, completing a voltaic circuit, rings an electric bell (this apparatus has been already described); or it may be applied to the mercurial thermometer, by sealing a platinum wire through the glass bulb into the mercury, and passing another wire through the open top of the capillary tube until within a short distance of the mercury—which distance is easily adjustable. On any increase of temperature the mercury expands, and, rising in the tube, makes contact with the uppermost wire, so ringing a bell, which will continue to sound until the temperature has again fallen below the point at which the thermometer is set. If these arrangements were fitted up in each room of a warehouse, an outbreak of fire would thus sound its alarm before any serious mischief had been done, and so much valuable property might be saved.

The General Electric Apparatus Company have been good enough to let me have one of their thermometers, which they propose to use as indicators of incipient spontaneous combustion in the coal stored on shipboard. In order to demonstrate its action, I have surrounded it in this dish with lumps of quicklime; on slaking the lime heat is produced, the buried mercury column expands, makes the required connection, and the bell sounds. A number of these thermometers, which are small and easily arranged, should be placed in certain known positions in the midst of any cargo liable to spontaneous ignition, and connected with an electric bell and indicator, situated in the captain's cabin or elsewhere, as may be desired. Thus, the slightest increase of temperature would instantly cause the bell to ring; and, by means of the indicator, the exact situation of that portion of the cargo, exposed to abnormal heat, could be at once discovered, and this in ample time to prevent one of the most terrible disasters to which the sea-faring community are liable. Surely, with such an instrument available, one ought never to hear of ships and passengers imperilled by this, which is, I suppose, one of the most frequent causes of fire at sea.

In the electric street-alarms, a great advance has been made towards the protection of the metropolis, and when the public have become used to the novelty of the thing, it would surely be worth the additional outlay to extend greatly these alarms is, I think, not generally known as it should be. The person who wishes to give notice of a fire must, after breaking the glass in front of the case, either pull or push the handle beneath (according to the system employed); this causes a bell to ring at the nearest fire-engine station; the signaller must then remain by the alarm-pillar until the engine arrives, otherwise much needless trouble will be caused, and much valuable time wasted.

In conclusion, a few words with regard to theatre protection. It has been frequently urged that the first point to be considered in studying this question, is the safety of the audience, and, after that, the preservation of the building; though, of course, these two matters are intimately connected. The best remedy for prevention of panic would seem, to inspire public confidence in the fire-resisting nature of the building, by the enforced adoption of systems such as those before mentioned for fire-proofing inflammable material, and by suitable arrangements for completely separating the stage from the auditorium.

With a good system of electric lighting properly applied, with entire absence of gas, by fire-proofing all inflammable material and dresses, by the complete disuse of cocoa-nut fibre matting, with a good brick wall between the stage and the "house," and by the adoption of a fire-resisting curtain, combined with good exits, there should be little danger of any catastrophe such as those which occurred lately at Nice and at Vienna, taking place in any of our public places of amusement.

The cutting off of the auditorium from the stage would, in case of a fire breaking ont behind the scenes, be of immense advantage, in preventing bodies of smoke and flame passing into the midst of the audience, and in this way suffocating them before they had time to escape; again, panic is frequently increased by the sudden blowing aside of the curtain (owing to the current of air set up by the burning material), and so disclosing to the terror-stricken crowd a vast mass of fire behind.

Many schemes have been suggested for accomplishing this end, such as the use of iron or asbestos curtains; of these the former is, perhaps, the more feasible, but is open to many objections.

An ingenious idea has lately been put forward—an idea which, carried into practice, would be simple and efficient. Instead of having one thick curtain, it is proposed that

across the top and between the two should run a light metal pipe connected with the hydrant service, and perforated throughout its entire length by holes placed at distances of two or three inches apart. Upon an alarm of fire, the curtain is to be lowered, and the water turned on; the latter would thus, by flowing through the perforations, saturate the whole curtain with water, making it very much heavier (indeed, it is a question whether in large theatres the weight would not be almost too much for a thin material to bear without givng way), and less liable to be blown aside; at the same time, if kept thoroughly wet, it would be absolutely fireproof; though the heat of a furnace were brought to bear upon it, the temperature could never rise beyond that of boiling water, all the excess of heat being used up in converting the water into steam.

I have here a model of proscenium and curtain so arranged; the wooden frame has been painted with asbestos paint, kindly supplied by the United Asbestos Company; you will observe that on lighting a fire beneath the curtain, both the curtain and the frame remain uninjured. This scheme is not open to the many objections that exist against others which have been suggested, for sprinkling water over an endangered auditorium, &c., because it may be readily tested as often as may be desired.

Finally, I must renew my thanks to Mr. J. H. Heathman (the author of an interesting little book upon "Preservation from Fire"), and to Messrs. Dennett and Ingle, the General Electric Apparatus Co., Messrs. Merryweather and Co., Messrs. Shand, Mason and Co., and to the United Asbestos Company, for the valuable assistance they have kindly rendered me.

NOTE.—Since this paper was read, a circumstance indicating a danger connected with electric lighting has come under my notice, and one which, I think, deserves special attention; it demonstrates forcibly the necessity for the utmost care in dealing with this mode of obtaining light, though I am not aware that, as yet, any fire other than the one to be mentioned has yet occurred from this precise method.

An arc-light and eight incandescence lamps were placed, in parallel arc, upon the same circuit; that is, they were so arranged that part of the current flowed through the arc-light, and the one-eighth part of the remaining current passed through each glow-light. By whole of the current was divided between the eight small lamps only; two or three of the carbon filaments gave way with the increased current to which they were submitted, and to those no further harm occurred. The heat given out by those which did not succumb was of course enormously increased, the temperature of the glass bulbs increased to a corresponding extent, and some artificial flowers in contact with the latter were ignited.

DISCUSSION.

The CHAIRMAN said Mr. McMillan had given a most lucid and instructive paper, and had explained several interesting points. In old days fire was considered one of the elements, but it had been long known by practical persons to be a combination of a combustible substance with a sufficient amount of heat, and a combustible substance was again divided into two parts, one being commonly known as the combustible substance, and the other as the supporter of combustion. Mr. McMillan had explained in a very practical manner the mode of dividing these elements so that a fire could not exist. If any one of the three elements were withdrawn, the fire would cease to exist. He had also touched on a great many points which could not be argued fully, but which were of great interest; for instance, the number of trades in which fire occurred in London, and had shown, as clearly as could be shown in a Table, the different risks of those trades; but, of course, no Table could show such a thing completely with regard to a vast city like London, where, in a single building, sometimes as many as twenty or thirty trades are congregated together. He had himself made great efforts in that direction, but as yet they were a long way from obtaining properly authenticated Tables, showing the risks of various trades. He had mentioned the danger of turning off gas in buildings, and the danger of leaving it on. He had also called attention to the practice of reading in bed, which he supposed almost everybody indulged in, and in large towns, of course, with gas-light. He (Captain Shaw) believed that it was the safest thing in a large building never to turn off the gas at the meter, and invariably advised people having charge of large buildings not to turn it off at all. With regard to the experiment Mr. McMillan had shown, of throwing sand on burning benzolene, there was no doubt that method was very efficacious wherever it could be practised, but the difficulty was that in some large places it would be impossible to have a sufficient amount of sand to cover the whole space in a state of ignition, and then they had to fall back on the old expedient of pouring water on it. He did not think that Mr. McMillan had sufficiently explained that water was not altogether inefficacious

perature of a portion of the liquid below its flashing point, then the fire must cease to exist. The statement of that fact might make some people's minds a little easier on that point. With regard to steam for extinguishing fire, he might say that experiments had been made over and over again, and he hoped some day to see, with some slight modification, a system of extinguishing fire by steam where it could be well applied, as, for instance, on board ship; but it was only right to warn those interested in the matter that hitherto such experiments had never yet been successful. He had tried them as far as anybody had power to do, and with more completeness than could be expected almost anywhere, and hitherto had not succeeded; still he did not give it up, and he hoped the time would come when, by the mixture of something with steam, the desired end would be obtained. At present, however, it would be a mistake to say that you could extinguish fire by steam alone.

Mr. SINCLAIR had been very much pleased with the paper, but must confess he was taken by surprise when he heard it stated that you could not depend much on carbonic acid gas for the extinction of fire. During the last fourteen years he had appeared before many audiences for the purpose of educating them on this matter of the chemical extinction of fire; and now he saw two rival "Extincteurs," made by the two leading makers in London; and what a revolution had occurred since a few years ago when he was laughed at for proposing the same thing. To-night Messrs. Shand and Mason and Merryweather were represented by rival "Extincteurs" to the "Fire Queen." During the fourteen years, he had been called upon several times to put out fires which water could not touch, but he would only refer to one at Wolverhampton a few weeks ago. There they played upon it with three fire-engines, and tried sand and ashes, until at last one of the firemen said, why not have one of the express engines they had been lately supplied with, and when that was brought into operation, the fire was immediately extinguished. That showed that carbonic acid gas had a powerful influence in extinguishing fire. There were various ways of producing carbonic acid gas; if it were not produced properly, it would fly off at the nozzle; but in Dick's "Fire Queen," that was guarded against.

Mr. SPILLER said the reader of the paper had slightly exaggerated the quantity of red fire which had undergone spontaneous ignition at the Royal Arsenal. As had been stated, he (Mr. Spiller) saw the accident, but it was only a small quantity, contained in a four-ounce bottle in the laboratory. Still that was sufficient to show that red-fire composition was a very dangerous material; and he was glad to see Captain Shaw present that evening, because he hoped greater care would be taken in future, especially in the case of theatres, with regard to the storage of this danger-

of October, 1866, immediately after the representation of "Der Freischütz," when large quantities of red fire had been employed. It occurred to him then that the man in charge of the composition had not a proper place to stow it away free from danger. In the following year Her Majesty's Theatre was burnt down, and there they had been performing "Don Giovanni," and other operas, where the hero had disappeared in a blaze of red fire. On that occasion he wrote to the *Times*, as he had done in the previous year to the *Chemical News*, calling attention to this matter, and he also wrote to the secretary of the County Fire Office. At that time there was no Captain Shaw, or anyone who had studied scientifically the history of conflagration, and, therefore, he did what he could to draw public attention to the matter. The same thing had been noticed by Mr. Tozer, of the Royal Arsenal, Professor Bloxam, of King's College, by Fownes in his "Manual of Chemistry," and Professor Pepper, and, therefore, it was highly desirable that greater precaution should be taken in the case of this dangerous substance.

Mr. MCMILLAN, in reply, said with regard to the question raised by Mr. Sinclair about the efficacy of carbonic acid, there was not the slightest doubt that it had a powerful influence in extinguishing flame, but with the ordinary "Extincteur" he still thought that the amount of carbonic acid dissolved in the water would be insufficient to have any material effect on the fire, though, of course, such as was present, would have the effect of lessening the flame.

The CHAIRMAN then proposed a vote of thanks to Mr. McMillan, which was carried unanimously.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 7th, 1883; JOHN STAINER, M.A., Mus. Doc., in the chair.

The following candidates were proposed for election as members of the Society:—

Barber, John Lees, Bowdon, Cheshire.
Biertumpfel, F. J., 138, Albany-street, N.W.
Bosanquet, Bernard, 131, Ebury-street, S.W.
Clunn, Philip Edward, 23, Regent-street, S.W.
Livesey, Montague, Boyle Farm, Thames Ditton, and Stourton Hall, Horncastle, Lincolnshire.
Ridley, Thomas Dawson, Coatham, Redcar.
Rumbelow, Harry Albert, The School House, Soham, Cambridgeshire.
Selberg, George Emil Carl, 195, The Grove, S.E.

The following candidates were balloted for and duly elected members of the Society:—

Bond, Miss Ellen Elizabeth, The Elms, Twickenham-

Field, Leopold, Lower Marsh, Lambeth, S.E.
Massey, William Henry, Twyford, Berks.
Pidgeon, Daniel, Holmwood, Putney-hill, S.W.

The paper read was—

THE HISTORY OF THE PIANOFORTE.

By A. J. Hipkins.

As this paper is composed from a technical point of view, some elucidation of facts, forming the basis of it, is desirable before we proceed to the chronological statement of the subject. These facts are the strings, and their strain or tension; the sound-board, which is the resonance factor; and the bridge, connecting it with the strings. The strings, soundboard, and bridge are indispensable, and common to all stringed imstruments. The special fact appertaining to keyboard instruments is the mechanical action interposed between the player and the instrument itself. The strings, owing to the slender surface they present to the air, are, however powerfully excited, scarcely audible. To make them sufficiently audible, their pulsations have to be communicated to a wider elastic surface, the soundboard, which, by accumulated energy and broader contact with the air, reinforces the strings' feeble sound. The properties of a string set in periodic vibration are the best known of the phenomena appertaining to acoustics. The molecules composing the string are disturbed in the string's vibrating length by the means used to excite the sound, and run off into sections, the comparative length and number of which depend partly upon the place in the string the excitement starts from; partly upon the force and the form of force that is employed; and partly upon the length, thickness, weight, strain, and elasticity of the string, with some small allowance for gravitation. The vibrating sections are of wavelike contour; the nodes or points of apparent rest being really knots of the greatest pressure from crossing streams of molecules. Where the pressure slackens, the sections rise into loops, the curves of which show the points of least pressure. Now, if the string be struck upon a loop, less energy is communicated to the string, and the carrying power of the sound proportionately fails. If the string be struck upon a node, greater energy ensues, and the carrying power proportionately gains. By this we recognise the importance of the place of contact, or striking, the necessity, in order to obtain good fundamental tone, which shall carry, of the note being started from a node.

If the hammer is hard, and impelled with force, the string breaks into shorter sections, and the discordant upper partials of the string, thus brought into prominence, make the tone harsh. If the hammer is soft, and the force employed is moderated, the harmonious partials of the longer sections strike the ear, and the tone is full and round. By the frequency of vibration, that is to say, the number of times a string runs through its complete changes one way and the other, say, for measurement, in a second of time, we determine the pitch, or relative acuteness of the tone as distinguished by the ear.

We know, with less exactness, that the sound-board follows similar laws. The formation of nodes is helped by the barring of the sound-board, a ribbing crosswise to the grain of the wood, which promotes the elasticity, and has been called the "soul" of stringed musical instruments. The sound-board itself is made of most carefully chosen pine; in Europe of the *Abies excelsa*, the spruce fir, which, when well grown, and of light even grain, is the best of all woods for resonance. The pulsations of the strings are communicated to the sound-board by the bridge, a thick rail of close-grained beech, curved so as to determine their vibrating lengths, and attached to the sound-board by dowels. The bridge is doubly pinned, so as to cut off the vibration at the edge of the bearing the strings exert upon the bridge. The shock of each separate pulsation, in its complex form, is received by the bridge, and communicated to such undamped strings as may, by their lengths, be sensitive to them; thus producing the Æolian tone commonly known as sympathetic, an eminently attractive charm in the tone of a pianoforte.

We have here strings, bridge, and sound-board, or belly, as it is technically called, indispensable for the production of the tone, and indivisible in the general effect. The proportionate weight of stringing has to be met by a proportionate thickness and barring of the sound-board, and a proportionate thickness and elevation of the bridge.

The tension of the strings is met by a framing, which has become more rigid as the drawing-power of the strings has been gradually increased. In the present concert grands of Messrs. Broadwood, that drawing-power may be stated as starting from 150 lb.

gradually increasing to about 300 lb. for each of the single strings in the bass. I will reserve for the historical description of my subject some notice of the different kinds of framing that have been introduced. It will suffice, at this stage, to say that it was at first of wood, and became, by degrees, of wood and iron; in the present day the iron very much preponderating. It will be at once evident that the object of the framing is to keep the ends of the strings apart. The near ends are wound round the wrest-pins, which are inserted in the wooden bed, called the wrest-plank, the strength and efficiency of which are most important for the tone and durability of the instrument. It is composed of layers of wainscot oak and beech, the direction of the grain being alternately longitudinal and lateral. Some makers cover the wrest-plank with a plate of brass; in Broadwood's grands, it is a plate of iron, into which, as well as the wood, the wrest-pins are screwed. The tuner's business is to regulate the tension, by turning the wrest-pins, in which he is chiefly guided by the beats which become audible from differing numbers of vibrations. The wrest-plank is bridged, and has its bearing like the sound-board; but the wrest-plank has no vibrations to transfer, and should, as far as possible, offer perfect insensibility to them.

I will close this introductory explanation with two remarks, made by the distinguished musician, mechanician, and inventor, Theobald Boehm, of Munich, whose inventions were not limited to the flute which bears his name, but include the initiation of an important change in the modern pianoforte, as made in America and Germany. Of priority of invention he says, in a letter to an English friend, "If it were desirable to analyse all the inventions which have been brought forward, we should find that in scarcely any instance were they the offspring of the brain of a single individual, but that all progress is gradual only; each worker follows in the track of his predecessor, and eventually, perhaps, advances a step beyond him." And concerning the relative value of inventions in musical instruments, it appears, from an essay of his which has been recently published, that he considers improvement in acoustical proportions the chief foundation of the higher or lower degree of perfection in all instruments, their mechanism being but of secondary value.

I will now proceed to recount briefly the history of the pianoforte from the earliest contemporary instruments, as far as they can be said to have entered into the historical domain. It has been my privilege to assist in proving that Bartolommeo Cristofori was, in the first years of the 18th century, the real inventor of the pianoforte, but with a wide knowledge and experience of how long it has taken to make any invention in keyed instruments practicable and successful, I cannot believe that Cristofori was the first to attempt to contrive one. I should rather accept his good and complete instrument as the sum of his own lifelong studies and experiments, added to those of generations before him, which have left no record for us as yet discovered.

The earliest mention of the name pianoforte *(piano e forte)*, applied to a musical instrument, has been recently discovered by Count Valdrighi in documents preserved in the Estense Library, at Modena. It is dated A.D. 1598, and the reference is evidently to an instrument of the spinet or cembalo kind; but how the tone was produced there is no statement, no word to base an inference upon. The name has not been met with again between the Estense document and Scipione Maffei's well-known description, written in 1711, of Cristofori's "gravecembalo col piano e forte." My view of Cristofori's invention allows me to think that the Estense "piano e forte" may have been a hammer cembalo, a very imperfect one, of course. But I admit that the opposite view of forte and piano, contrived by registers of spinet-jacks, is equally tenable.

Bartolommeo Cristofori was a Paduan harpsichord maker, who was invited by Prince Ferdinand dei Medici to Florence, to take charge of the large collection of musical instruments the Prince possessed. At Florence, he produced the invention of the pianoforte, in which he was assisted and encouraged by this high-minded, richly cultivated, and very musical Prince. Scipione Maffei tells us that in 1709, Cristofori had completed four of the new instruments, three of them being of the usual harpsichord form, and one of another form, which he leaves undescribed. It is interesting to suppose that Handel may have tried one or more of these four instruments during the stay he made at Florence in 1708. But it is not likely that he was at all impressed with the potentialities of the invention any more than John Sebastian Bach was in after years, when he tried the pianofortes of Silber-

Maffei's essay, from which I have had a working model accurately made, shows that in the first instruments the action was not complete, and it may not have been perfected when Prince Ferdinand died in 1713. But there are Cristofori grand pianos preserved at Florence, dated respectively 1720 and 1726, in which an improved construction of action is found, and of this I also exhibit a model. There is much difference between the two. In the second, Cristofori had obtained his escapement with an undivided key, reconciling his depth of touch, or keyfall, with that of the contemporary harpsichord, by driving the escapement lever through the key. He had contrived means for regulating the escapement distance, and had also invented the last essential of a good pianoforte action, the check. I will explain what is meant by escapement and check. When, by a key being put down, the hammer is impelled towards the strings, it is necessary for their sustained vibration that, after impact, the hammer should rebound or escape; or it would, as pianoforte-makers say, "block," damping the strings at the moment they should sound. A dulcimer player gains his elastic blow by the free movement of the wrist. To gain a similarly elastic blow mechanically, in his first action, Cristofori cut a notch in the butt of his hammer, from which the escapement lever, "linguetta mobile," as he called it—"hopper," as we call it—being centred at the base, moved forward when the key was put down to the extent of its radius, and after the delivery of the blow returned to its resting-place by the pressure of a spring. The first action gave the blow with more direct force than the second, which had the notch upon what is called the underhammer, but was defective in the absence of any means to regulate the distance of the "go-off," or "escapement" from the string. In the second action, a small check before the hopper is intended to regulate it, but does so imperfectly. The pianoforte had to wait for 50 years for satisfactory regulation of the escapement.

In the first action, the hammer rests in a silken fork, dropping the whole distance of the rise of every blow. The check in the second action, the "paramartello," is next in importance to the escapement. It catches the back part of the hammer at different points of the radius, responding to the amount of force the player has used upon the key. So that, in repeated blows, the rise of the hammer is modified, and the notch is nearer to the return-

I have given the first place in description to Cristofori's actions, instead of to the "cembalo" or instrument, to which they were applied, because piano and forte, from touch, became possible through them, and what else was accomplished by Cristofori was due, primarily, to the dynamic idea. He strengthened his harpsichord sound-board against a thicker stringing, renouncing the cherished sound-holes. Yet the sound-box notion clung to him, for he made openings in his sound-board rail for air to escape. He ran a string-block round the case, entirely independent of the sound-board, and his wrest-plank, which also became a separate structure, removed from the sound-board by the gap for the hammers, was now a stout oaken plank, which, to gain an upward bearing for the strings, he inverted, driving his wrest-pins through in the manner of a harp, and tuning them in like fashion to the harp. He had two strings to a note, but it did not occur to him to space them into pairs of unisons. He retained the equidistant harpsichord scale, and had, at first, under-dampers, later, over-dampers, which fell between the unisons thus equally separated. Cristofori died in 1731. He had pupils, one of whom made, in 1730, the "Rafael d'Urbino," the favourite instrument of the great singer Farinelli. The story of inventive Italian pianoforte making ends thus early, but to Italy the invention indisputably belongs.

The first to make pianofortes in Germany was the famous Freiberg organ-builder and clavichord maker, Gottfried Silbermann. He submitted two pianofortes to the judgment of John Sebastian Bach in 1726, which judgment was, however, unfavourable; the trebles being found too weak, and the touch too heavy. Silbermann, according to the account of Bach's pupil, Agricola, being much mortified, put them aside, resolving not to show them again unless he could improve them. We do not know what these instruments were, but it may be inferred that they were copies of Cristofori, or were made after the description of his invention, by Maffei, which had already been translated from Italian into German, by König, the court poet at Dresden, who was a personal friend of Silbermann. With the next anecdote which narrates the purchase of all the pianofortes Silbermann had made by Frederick the Great, we are upon surer ground. This well accredited occurrence took place in 1746. In the following year occurred Bach's celebrated visit to Potsdam, when he played upon one or

described one in 1772. I had this one, which was known to have remained in the new palace at Potsdam until the present time unaltered, examined, and, by a drawing of the action, found it was identical with Cristofori's. Not, however, being satisfied with one example, I resolved to go myself to Potsdam, and being furnished with permission from H.R.H. The Crown Princess of Prussia, I was enabled in September, 1881, to set the question at rest of how many grand pianofortes by Gottfried Silbermann there were still in existence at Potsdam, and what they were like. At Berlin there are none, but at Potsdam, in the music-rooms of Frederick the Great, which are in the town palace, the new palace, and Sans Souci—left, it is understood, from the time of Frederick's death undisturbed—there are three of these Silbermann pianofortes. All three are, with unimportant differences having nothing to do with structure, Cristofori instruments, wrest-plank, sound-board, string-block, and action; the harpsichord scale of stringing being still retained. The work in them is undoubtedly good; the sound-boards have given in the trebles, as is usual with old instruments, from the strain; but I should say all three might be satisfactorily restored. Some other pianofortes seem to have been made in North Germany about this time, as our own poet Gray bought one in Hamburg in 1755, in the description of which we notice the desire to combine a hammer action with the harpsichord, which so long exercised men's minds.

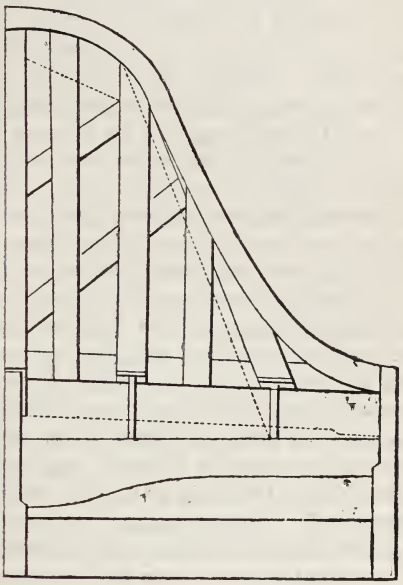
The Seven Years' War put an end to pianoforte-making on the lines Silbermann had adopted in Saxony. A fresh start had to be made a few years later, and it took place contemporaneously in South Germany and England. The results have been so important that the grand pianofortes of the Augsburg Stein, and the London Backers may be regarded, practically, as re-inventions of the instrument. The decade 1770-80 marks the emancipation of the pianoforte from the harpsichord, of which before it had only been deemed a variety. Compositions appear written expressly for it, and a man of genius, Muzio Clementi, who subsequently became the head of the pianoforte business now conducted by Messrs. Collard, came forward to indicate the special character of the instrument, and found an independent technique for it.

A few years before, the familiar domestic square piano had been invented. I do not think clavichords could have been altered to square pianos, as they were wanting in sufficient depth of case, but that the suggestion was from the clavichord is certain, the same kind of case and key-board being used. German authorities attribute the invention to an organ builder, Friederici of Gera, and give the date about 1758 or 1760. I have advertised in public papers, and have had personal inquiry made for one of Friederici's "Fort Bien," as he is said to have called his instrument. I have only succeeded in learning this much, that Friederici is considered to have been of later date than has been asserted in the text-books. Until more conclusive information can be obtained, I must be permitted to regard a London maker, but a German by birth, Johannes Zumpe, as the inventor of the instrument. It is certain that he introduced that model of square piano which speedily became the fashion, and was chosen for general adoption everywhere. Zumpe began to make his instruments about 1765. His little square, at first of nearly five octaves, with the "old man's head" to raise the hammer, and "mopstick" damper, was in great vogue, with but little alteration, for forty years; and that, in spite of the manifest improvements of John Broadwood's wrest-plank, and John Geib's "grasshopper." After the beginning of this century, the square piano became much enlarged and improved by Collard and Broadwood, in London, and by Petzold, in Paris. It was overdone in the attempt to gain undue power for it, and, about twenty years ago, sank in the competition with the later cottage pianoforte, which was always being improved.

To return to the grand pianoforte. The origin of the Viennese grand is rightly accredited to Stein, the organ builder, of Augsburg. I will call it the German grand, for I find it was as early made in Berlin as Vienna. According to Mozart's correspondence, Stein had made some grand pianos in 1777, with a special escapement, which did not "block" like the pianos he had played upon before. When I wrote the article "Pianoforte" in Dr. Grove's "Dictionary" no Stein instrument was forthcoming, but the result of the inquiries I had instituted at that time ultimately brought one forward, which has been secured by the curator of the Brussels Museum, M. Victor Mahillon. This instrument, with Stein's action and two unison scale, is dated 1780. Mozart's grand piano, preserved at Salzburg, made by Walther, is a nearly contemporary copy of Stein, and so also are the grands by Huhn of Berlin, which I took notes of at Berlin and Potsdam; the latest of these

is dated 1790. An advance, shown by these instruments of Stein and Stein's followers, is in the spacing of the unisons; the Huhn grands having two strings to a note in the lower part of the scale, and three in the upper. The Cristofori-Silbermann inverted wrest-plank has reverted to the usual form; the tuning pins and downward bearing being the same as in the harpsichord. There are no steel arches as yet between the wrest-plank and the belly-rail in these German instruments. As to Stein's escapement, his hopper was fixed behind the key; the axis of the hammer rising on a principle which I think is older than Stein, but have not been able to trace to its source, and the position of his hammer is reversed. Stein's light and facile movement with shallow key-fall, resembling Cristofori's in bearing little weight, was gratefully accepted by the German clavichord players, and, re-acting, became one of the determining agents of the piano music and style of playing of the Vienna school. Thus arose a fluent execution of a rich figuration and brilliant passage playing, with but little inclination to sonorousness of effect, lasting from the time of Mozart's immediate followers to that of Henri Herz; a period of half a century. Knee-pedals, as we translate "génouillères," were probably in vogue before Stein, and were levers pressed with the knees, to raise the dampers, and leave the pianoforte undamped, a register approved of by Carl Philip Emmanuel Bach, who regarded the undamped pianoforte as the more agreeable for improvising. He appears, however, to have known but little of the capabilities of the instrument, which seemed to him coarse and inexpressive beside his favourite clavichord. Stein appears to have made use of the "una corda" shift. Probably by knee-pedals, subsequently by foot-pedals, the following effects were added to the Stein pianos. The harpsichord "harp"-stop, which muted one string of each note by a piece of leather, became, by the interposition of a piece of cloth between the hammer and the strings, the piano, harp, or *celeste*. The more complete sourdine, which muted all the strings by contact of a long strip of leather, acted as the staccato, pizzicato, or pianissimo. The Germans further displayed that ingenuity in fancy stops, Mersenne had attributed to them in harpsichords more than a hundred and fifty years before, by a bassoon pedal, a card which, by a rotatory half-cylinder just impinging upon the strings, produced a reedy twang; also by pedals for triangle, cymbals, bells, and tambourine, the last drumming on the sound-board itself. Several of these contrivances may be seen in a six-pedal grand pianoforte belonging to Her Majesty the Queen, at Windsor Castle, bearing the name as maker of Stein's daughter, Nannette, who was a friend of Beethoven. The diagram represents the wooden framing of such an instrument.

FIG. 1.



We gather from Burney's contributions to "Rees's Cyclopædia," that after the arrival of John Christian Bach in London, A.D. 1759, a few grand pianofortes were attempted, by the second-rate harpsichord makers, but with no particular success. If the workshop tradition can be relied upon that several of Silbermann's workmen had come to London about that time, the so-called "twelve apostles," more than likely owing to the Seven Years' War, we should have here men acquainted with the Cristofori model, which Silbermann had taken up, and the early grand pianos referred to by Burney would be on that model. I should say the "new instrument" of Messrs. Broadwood's playbill of 1767 was such a grand piano; but there is small chance of ever finding one now, and if an instrument were found, it would hardly retain the original action, as Messrs. Broadwood's books of the last century show the practice of refinishing instruments which had been made with the "old movement." Burney distinguishes Ameri-

cus Backers by special mention. He is said to have been a Dutchman. Between 1772 and and 1776, Backers produced the well-known English action, which has remained the most durable, and one of the best up to the present day. It refers in direct leverage to Cristofori's first action. It is opposite to Stein's contemporary invention, which has the hopper fixed. In the English action, as in the Florentine, the hopper rises with the key. To the direct leverage of Cristofori's first action, Backers combined the check of the second, and then added an important invention of his own, a regulating screw and button for the escapement. Backers died in 1776. It is unfortunate we can refer to no pianoforte made by him. I should regard it as treasure trove if one were forthcoming in the same way that brought to light the authentic one of Stein's. As, however, Backers' intimate friends, and his assistants in carrying out the invention, were John Broadwood and Robert Stodart, we have, in their early instruments, the principle and all the leading features of the Backers' grand. The increased weight of stringing was met by steel arches placed at intervals between the wrest-plank and the belly-rail, but the belly-rail was still free from the thrust of the wooden bracing, the direction of which was confined to the sides of the case, as it had been in the harpsichord. Stodart appears to have preceded Broadwood in taking up the manufacture of the grand piano by four or five years. In 1777, he patented an alternate pianoforte and harpsichord, the drawing of which patent shows the Backers action. The pedals he employed were to shift the harpsichord register, and to bring on the octave stop. The present pedals were introduced in English and grand pianos by 1785, and are attributed to John Broadwood, who appears to have given his attention at once to the improvement of Backers' instrument. Hitherto the grand piano had been made with an undivided belly-bridge, the same as the harpsichord had been; the bass strings, in three unisons, to the lowest note, being of brass. Theory would require that the notes of different octaves should be multiples of each other, and that the tension should be the same for each string. The lowest bass strings, which at that time were the note F, would thus require a vibrating length of about twelve feet. As only half this length could be afforded, the difference had to be made up in the weight of the strings and their tension, which led, in these early grands, to many inequalities. The three octaves towards the treble could, with care, be adjusted, the lengths being practically the ideal lengths. It was in the bass octaves (pianos were then of five octaves) the inequalities were more conspicuous. To make a more perfect scale, and equalise the tension, was the merit and achievement of John Broadwood, who joined to his own practical knowledge and sound intuitions the aid of professed men of science. The result was, the divided bridge, the bass strings being carried over the shorter division, and the most beautiful grand pianoforte in its lines and curves that has ever been made was then manufactured. In 1791, he carried his scale up to C, five and a-half octaves; in 1794, down to C, six octaves, always with care for the artistic form. The pedals were attached to the front legs of the stand, on which the instrument rested. The right foot pedal acted first as the piano register, shifting the impact of each hammer to two unisons instead of three; a wooden stop in the right hand key-block permitted the action to be shifted yet further to the right, and reducing the blow to one string only, produced the pianissimo register, or *una corda*, of indescribable attractiveness of sound. The cause of this was in the reflected vibration through the bridge to the untouched strings. The present school of pianoforte playing rejects this effect altogether, but Beethoven valued it, and indicated its use in some of his great works. Steibert called the *una corda* the *celeste*, which is more appropriate to it than Adam's application of this name to the harp-stop, by which the latter has gone ever since.

Up to quite the end of the last century, the dampers were continued to the highest note in the treble. They were like harpsichord dampers raised by wooden jacks, with a rail or stretcher to regulate their rise, which served also as a back touch to the keys. I have not discovered the exact year when, or by whom, the treble dampers were first omitted, thus leaving that part of the scale undamped. This bold act gave the instrument many sympathetic strings free to vibrate from the bridge when the rest of the instrument was played; each string, according to its length, being an aliquot division of a lower string. This gave the instrument a certain brightness or life throughout, an advantage which has secured its universal adoption. The expedients of an untouched octave string, and of utilising those lengths of wire that lie beyond the bridges, have been brought into notice of late years, but the latter was early in the century essayed by W. F. Collard. From difficulties of tuning,

owing to friction and other causes, the real gain of these expedients is small, and when we compare them with the natural resources we have always at command in the normal scale of the instrument, is not worth the cost. The inventor of the damper register opened a floodgate to such aliquot reinforcement as can be got in no other way. Each lower note struck of the undamped instrument, by excitement from the sound-board carried through the bridge, sets vibrating higher strings, which, by measurement, are primes to its partials; and each higher string struck calls out equivalent partials in the lower strings. Even partials above the primes will excite their equivalents up to the twelfth and double octave. What a glow of tone-colour there is in all this harmonic reinforcement, and who would now say that the pedals should never be used? By their proper use, the student's ear is educated to a refined sense of distinction of consonance and dissonance, and the intention and beauty of Chopin's pedal work becomes revealed.

The next decade, 1790-1800, brings us to French grand pianoforte making, which was then taken up by Sebastian Erard. This ingenious mechanic and inventor travelled the long and dreary road along which nearly all who have tried to improve the pianoforte have had to journey. He appears, at first, to have adopted the existing model of the English instrument in resonance, tension, and action, and to have subsequently turned his attention to the action, most likely with the idea of combining the English power of gradation with the German lightness of touch. Erard claimed, in the specification to a patent for an action, dated 1808, "the power of giving repeated strokes, without missing or failure, by very small angular motions of the key itself."

Once fairly started, the notion of repetition became the dominant idea with pianoforte-makers, and to this day, although less insisted upon, engrosses time and attention that might be more usefully directed. Some great players, from their point of view of touch, have been downright opposed to repetition actions. I will name Kalkbrenner, Chopin, and, in our own day, Dr. Hans von Bülow. Yet the Erard's repetition, in the form of Herz's reduction, is, at present, in greater favour in America and Germany, and is more extensively used, than at any previous period.

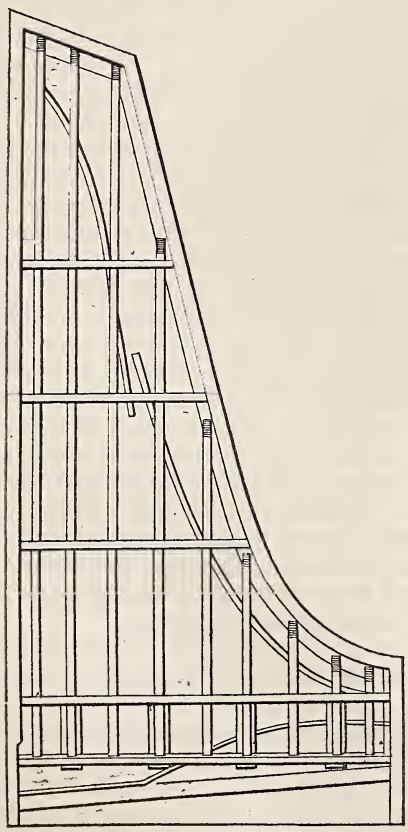
The good qualities of Erard's action, completed in 1821, the germ of which will be found in the later Cristofori, are not, however, due to repetition capability, but to other causes, chiefly, I will say, to counterpoise. The radical defect of repetition is that the repeated note can never have the tone-value of the first; it depends upon the mechanical contrivance, rather than the finger of the player, which is directly indispensable to the production of satisfactory tone. When the sensibility of the player's touch is lost in the mechanical action, the corresponding sensibility of the tone suffers; the resonance is not, somehow or other, sympathetically excited.

Erard re-discovered an upward bearing, which had been accomplished by Cristofori a hundred years before, in 1808. A down-bearing bridge to the wrest-plank, with hammers striking upwards, are clearly not in relation; the tendency of the hammer must be, if there is much force used, to lift the string from its bearing, to the detriment of the tone. Erard reversed the direction of the bearing of the front bridge, substituting for a long, pinned, wooden bridge, as many little brass bridges as there were notes. The strings passing through holes bored through the little bridges, called agraffes, or studs, turned upwards towards the wrest-pin. By this the string was forced against its rest instead of off it. It is obvious that the merit of this invention would in time make its use general. A variety of it was the long brass bridge, specially used in the treble on account of the pleasant musical box-like tone its vibration encouraged. Of late years another upward bearing has found favour in America and on the Continent, the Capo d'Astro bar of M. Bord, which exerts a pressure upon the strings at the bearing point.

About the year 1820, great changes and improvements were made in the grand pianoforte both externally and in the instrument. The harpsichord boxed-up front gave way to the cylinder front, invented by Henry Pape, a clever German pianoforte-maker who had settled in Paris. Who put the pedals upon the familiar lyre I have not been able to learn. It would be in the Empire time, when a classical taste was predominant. But the greatest change was from a wooden resisting structure to one in which iron should play an important part. The invention belongs to this country, and is due to a tuner named William Allen, a young Scotchman, who was in Stodart's employ. With the assistance of the foreman, Thom, the invention was completed, and a patent was taken out, dated the 15th of January, 1820, in which Thom was a partner. The patent was, however, at once

secured by the Stodart, their employers. The object of the patent was a combination of metal tubes, with metal plates, the metallic tubes extending from the plates which were attached to the string-block to the wrest-plank. The metal plates now held the hitch-pins, to which the farther ends of the strings were fixed, and the force of the tension was, in a great measure, thrown upon the tubes. The tubes were a mistake; they were of iron over the steel strings, and brass over the brass and spun strings, the idea being that

FIG. 2.



WILLIAM ALLEN.

of the compensation of tuning when affected by atmospheric change, also a mistake. However, the tubes were guaranteed by stout wooden bars crossing them at right angles. At once a great advance was made in the possibility of using heavier strings, and the great merit of the invention was everywhere recognised. James Broadwood was one of the first to see the importance of the invention, if it were transformed into a stable principle. He had tried iron tension bars in past years, but without success. It was now due to his firm to introduce a fixed stringed plate, instead of plates intended to shift, and in a few years to combine this plate with four solid tension bars, for which combination he, in 1827, took out a patent, claiming as the motive for the patent the string-plate; the manner of fixing the hitch-pins upon it, the fourth tension bar, which crossed the instrument about the middle of the scale, and the fastening of that bar to the wooden brace below, now abutting against the belly-rail, the attachment being effected by a bolt passing through a hole cut in the sound-board.

This construction of grand pianoforte soon became generally adopted in England and France. Messrs. Erard, who appear to have had their own adaptation of tension bars, introduced the harmonic bar in 1838. This, a short bar of gun-metal, was placed upon the wrest-plank immediately above the bearings of the treble, and consolidated the plank by screws tapped into it of alternate pressure and drawing power. In the original invention a third screw pressed upon the bridge. By this bar a very light ringing treble tone was gained. This was followed by a long harmonic bar extending above the whole length of the wrest-plank, which it defends from any tendency to rise, by downward pressure obtained by screws. During 1840-50, as many as five and even six tension-bars were used in grand pianofortes, to meet the ever-increasing strain of thicker stringing. The bars were strutted against a metal edging to the wrest-plank, while the ends were prolonged forward until they abutted against its solid mass on the key-board side of the tuning-pins. The space required for fixing them cramped the scale, while the strings were divided into separate batches between them. It was also difficult to so adjust each bar that it should bear its proportionate share of the tension; an obvious cause of inequality.

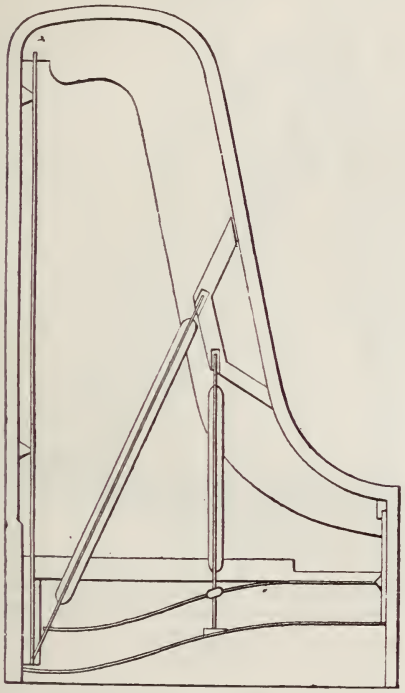
Towards the end of this period a new direction was taken by Mr. Henry Fowler Broadwood, by the introduction of an iron-framed pianoforte, in which the bars should be reduced in number, and with the bars the steel arches, as they were still called, although they were no longer arches but struts.

In a grand pianoforte, made in 1847, Mr. Broadwood succeeded in producing an instrument of the largest size, practically depending upon iron alone. Two tension-bars sufficed, neither of them breaking into the scale; the first, nearly straight, being almost parallel

with the lowest bass string; the second, presenting the new feature of a diagonal bar crossed from the bass corner to the string-plate, with its thrust at an angle to the strings.

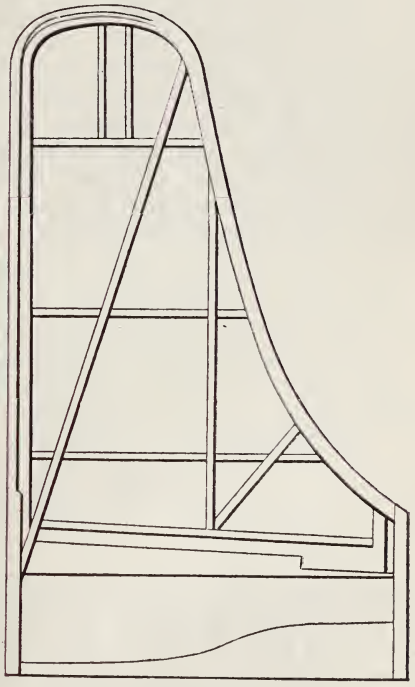
There were reasons which induced Mr. Broadwood to somewhat modify and improve this framing, but with the retention of its leading feature, the diagonal bar; which was found to be of supreme importance in bearing the tension where it is most concentrated. From 1852, his concert grands have had, in all, one bass bar, one diagonal bar, a middle bar with arch beneath, and the treble cheek bar. The middle bar is the only one directly crossing the scale, and breaking it. It is strengthened by feathered ribs, and is fastened by screws to the wooden brace below. The three bars and diagonal bar, which is also feathered, abut firmly on the string-plate, which is fastened down to the wooden framing by screws. Since 1862, the wooden wrest-plank has been covered with a plate of iron, the iron screw-pin plate, bent at a right angle in front. The wrest-pins are screwed into this plate, and again in the wood below. The agraffes, which take the upward bearings of the strings, are firmly screwed into this plate. The long harmonic bar, of gun metal, lies

FIG. 3.



BROADWOOD.

FIG. 4.



BROADWOOD.

immediately above the agraffes, and crossing the wrest-plank in its entire width, serves to keep it, at the bearing line, in position. This construction is the farthest advance of the English pianoforte.

Almost simultaneously with it has arisen a new development in America, which, beginning with Conrad Meyer, about 1833, has been advanced by the Chickerings and Steinways to the well-known American and German grand pianoforte of the present day. It was perfected in America about 1859, and has been taken up since by the Germans almost universally, and with very little alteration. Two distinct principles have been developed and combined—the iron framing in a single casting, and the cross or overstringing. I will deal with the last first, because it originated in England, and was the invention of Theobald Boehm, the famous improver of the flute. In "Grove's Dictionary" I have given an approximate date to his overstringing as 1835, but reference to Boehm's correspondence with Mr. Walter Broadwood shows me that 1831 was really the time, and that Boehm employed Gerock and Wolf, of 79, Cornhill, London, musical instrument makers, to carry out his experiment. Gerock being opposed to an oblique direction

of the strings and hammers, Boehm found a more willing coadjutor in Wolf. As far as I can learn, a piccolo, a cabinet, and a square piano were thus made over-strung. Boehm's argument was that a diagonal was longer within a square than a vertical, which, as he said, every school-boy knew. The first over-strung grand pianos seen in London were made by Lichtenthal, of St. Petersburg; not so much for tone as for symmetry of the case, two instruments so made were among the curiosities of the Great Exhibition of 1851. Some years before this, Henry Pape had made experiments in cross-stringing, with the intention to economise space. His ideas were adopted and continued by the London maker, Tomkisson, who acquired Pape's rights for this country. The iron framing in a single casting is a distinctly American invention, but proceeding, like the over-stringing, from a German by birth. The iron casting for a square piano of the American Alpheus Babcock, may have suggested Meyer's invention; it was, however, Conrad Meyer who,

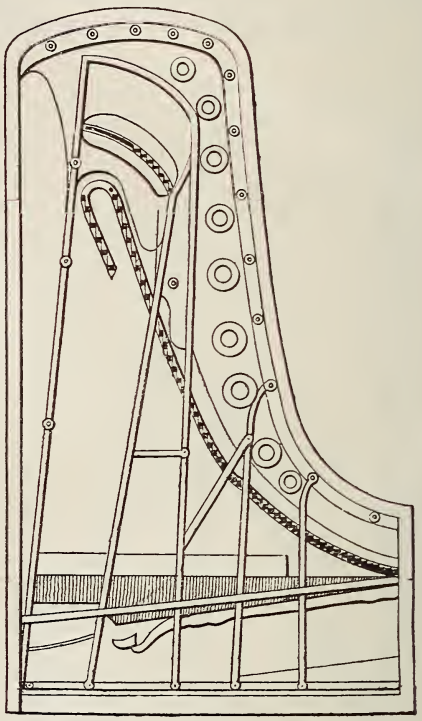
Fig. 5.



Meyer.

in Philadelphia, and in 1833, first made a real iron frame square pianoforte. The gradual improvement upon Meyer's invention, during the next quarter of a century, are first due to the Chickerings and then the Steinways. The former over-strung an iron frame square, the latter over-strung an iron frame grand, the culmination of this special make since of general American and German adoption. It will be seen that, in the American make, the number of tension bars has not been reduced, but a diagonal support has, to a certain extent, been accepted and adopted. The sound-board bridges are much further apart than obtains with the English grand, or with the Anglo-French Erard. The advocates of the American principle point out the advantages of a more open scale, and more equal pressure on the sound-board. They likewise claim, as a gain, a greater tension. I have no quite accurate information as to what the sum of the tension may be of an American grand piano. One of Broadwood's, twenty years ago, had a strain of 16½ tons; the strain has somewhat increased since then. The remarkable improvement in wiredrawing which has been made in Birmingham, Vienna, and Nuremberg of late years, has rendered these high tensions of far easier attainment than they would have been earlier in the century.

Fig. 6.



Steinway.

For me, the great drawback to one unbroken casting, is in the vibratory ring inseparable from any metal system that has no resting places to break the uniform reverberation proceeding from metal. We have already seen how readily the strings take up vibrations, which are only pure when, as secondary vibrations, they arise by reversion from the sound-board. If vibration arises from imperfectly elastic wood, we hear a dull wooden thud; if it comes from metal, partials of the strings are reinforced that should be left undeveloped, which give a false ring to the tone, and an after-ring that blurs *legato* playing, and nullifies the *staccato*. I do not pose as the obstinate advocate of parallel stringing, although I believe that, so

far, it is the most logical and the best; the best, because the left-hand division of the instrument is free from a preponderance of dissonant high partials, and we hear the light and shade, as well as the cantabile of that part, better than by any overstrung scale that I have yet met with. I will not, I say, offer a final judgment, because there may come a possible improvement of the over-strung or double diagonal scale, if that scale is persisted in, and inventive power is brought to bear upon it, as valuable as that which has carried the idea thus far.

I have not had time to refer other than incidentally to the square pianoforte, which has become obsolete. I must, however, give a separate historical sketch of the upright pianoforte, which has risen into great favour and importance, and in its development—I may say its invention—belongs to this present 19th century. The form has always recommended the upright on the score of convenience, but it was long before it occurred to anyone to make an upright key-board instrument reasonably. Upright harpsichords were made nearly four hundred years ago; a very interesting 17th century one was sold lately in the great Hamilton sale—sold, I grieve to say, to be demolished for its paintings. But all vertical harpsichords were horizontal ones, put on end on a frame; and the book-case upright grand pianos, which, from the eighties, were made right into the present century, were horizontal grands similarly elevated. The real inventor of the upright piano, in its modern and useful form, was that remarkable Englishman, John Isaac Hawkins, the inventor of ever-pointed pencils; a civil engineer, poet, preacher, and phrenologist. While living at Border Town, New Jersey, U.S.A., Hawkins invented the cottage piano; portable grand he called it, and his father, Isaac Hawkins, to whom, in Grove's "Dictionary," I have attributed the invention, took out, in the year 1800, the English patent for it. I can fortunately show you one of these original pianinos, which belongs to Messrs. Broadwood; it is a wreck, but you will discern that the strings descend nearly to the floor, while the key-board, a folding one, is raised to a convenient height between the floor and the upper extremities of the strings. Hawkins had an iron frame and tension rods, within which the belly was entirely suspended; a system of tuning by mechanical screws; an upper metal bridge; equal length of string throughout; metal supports to the action in which a later help to repetition was anticipated—the whole instrument being independent of the case. Hawkins tried also a lately revived notion of coiled strings in the bass, doing away with tension. Lastly, he sought for a *sostinente*, which has been tried for from generation to generation, always to fail, but which, even if it does succeed, will produce another kind of instrument, not a pianoforte, which owes so much of its charm to its unsatiating, evanescent tone.

Once introduced into Hawkins's native country, England, the rise of the upright piano became rapid. In 1807, at latest, the now obsolete high cabinet piano was fairly launched. In 1811, Wornum produced a diagonal; in 1813, a vertical cottage piano. Previously, essays had been made to place a square piano upright on its side, for which Southwell, an Irish maker, took out a patent in 1798; and I can, fortunately, show you one of these instruments, kindly lent for this paper by Mr. Walter Gilbey. I have also been favoured with photographs by Mr. Simpson, of Dundee, of a precisely similar upright square. I show his drawing of the action—the Southwell sticker action. W. F. Collard patented another similar experiment in 1811. At first the sticker action with a leather hinge to the hammer-butt was the favourite, and lasted long in England. The French, however, were quick to recognise the greater merit of Wornum's principle of the crank action, which, and strangely enough through France, has become very generally adopted in England, as well as Germany and elsewhere. I regret I am unable to show a model of the original crank action, but Mr. Wornum has favoured me with an early engraving of his father's invention. It was originally intended for the high cabinet piano, and a patent was taken out for it in 1826. But many difficulties arose, and it was not until 1829 that the first cabinet was so finished. Wornum then applied it, in the same year, to the small upright—the piccolo, as he called it—the principle of which was, through Pleyel and Pape, adopted for the pianino manufacture in Paris. Within the last few years we have seen the general introduction of Bord's little pianino, called in England, ungrammatically enough, pianette, in the action of which that maker cleverly introduced the spiral spring. And, also, of those large German over-strung and double over-strung upright pianos, which, originally derived from America, have so far

met with favour and sale in this country as to induce some English makers, at least in the principle, to copy them.

I will conclude this historical sketch by remarking, and as a remarkable historical fact, that the English firms which in the last century introduced the pianoforte, to whose honourable exertions we owe a debt of gratitude, with the exception of Stodart, still exist, and are in the front rank of the world's competition. I will name Broadwood (whose flag I serve under), Collard (in the last years of the last century known as Longman and Clementi), Erard (the London branch), Kirkman, and, I believe, Wornum. On the Continent, there is the Paris Erard house; and, at Vienna, Streicher, a firm which descends directly from Stein of Augsburg, the inventor of the German pianoforte, the favourite of Mozart, and of Beethoven in his virtuoso period, for he used Stein's grands at Bonn. Distinguished names have risen in the present century, some of whom have been referred to. To those already mentioned, I should like to add the names of Hopkinson and Brinsmead in England; Bechstein and Blüthner in Germany; all well-known makers.

DISCUSSION.

Mr. EAVESTAFFE thought it was not made sufficiently plain in the paper that the credit of inventing the iron pianoforte belonged to an Englishman (Hawkins). He had himself seen a Hawkins's pianoforte made with an iron frame in 1806 or 1808, and his father knew Hawkins well. He did not think, therefore, the Americans should have the credit of the iron pianoforte.

The CHAIRMAN said Mr. Hipkins only gave the Americans the credit of making the iron frame in one casting. It was distinctly stated that Hawkins was an Englishman.

Mr. CHALLEN said he had listened with very great pleasure to the paper, many portions of which he could confirm if it were necessary, but he did not know that he could contribute much further information on the subject. One point occurred to him with regard to the introduction of cross-stringing by Hopkinson. He knew him intimately as a young man, and his impression was, that he introduced this cross-stringing somewhere about 1830, or even earlier. He did not himself remember it at that date, but he did very shortly afterwards.

The CHAIRMAN said he supposed it must be taken as a compliment to Mr. Hipkins that no one came forward to contest anything he had advanced. He had pointed out several particulars in which Englishmen were entitled to credit where it was not generally given to them, and there might be other cases in which some present might be able to show that Englishmen had contributed to the improvement of the pianoforte. It not unfrequently happened, he believed, that Englishmen made the preliminary steps in an invention, the credit of which was afterwards carried off by someone else. Very few people, when they went into a room and sat down to a pianoforte, had the least notion of the enormous amount of labour and science which had been expended on it; and he felt sure that many, on reading this excellent paper, would be glad to examine an instrument, and see how the various remarks applied. He feared, from the pianoforte being such a common instrument, that many persons were apt to overlook its real value.

Mr. HIPKINS then exhibited and explained the different pianoforte actions, including the Erard and Steinway.

Mr. HIPKINS said there was no doubt Hopkinson got the idea from Pape, in Paris; but he could not be quite sure who was the first to introduce it in England; he believed it was Boehm, but was not certain.

The CHAIRMAN then proposed a cordial vote of thanks to Mr. Hipkins for his paper, which displayed a large amount of careful historical research, and was remarkable for the perfect fairness and impartiality with which he had dealt with the whole subject.

The vote of thanks was carried unanimously, and the proceedings terminated.

Miscellaneous.

CHAMPAGNE MAKING IN FRANCE.

In the champagne district the greatest attention, says Consul Frisbie, is paid to the picking of the grapes, the fruit being supported in the left hand so as to prevent the riper grapes from falling, and care being taken not to bruise the fruit in throwing it into the baskets. These baskets, when full, are emptied into larger ones, and minutely examined, in order that all the bruised, rotten, and unripe grapes may be removed. If the grapes are very ripe, wisps of straw are placed in the bottoms of the baskets to prevent jolting and bruising. The picking usually commences with daylight, and the vintagers assert that the grapes gathered at sunrise always produce the best wine, and that by plucking the grapes when the early morning sun is upon them they are believed to yield much more juice; later in the day, in spite of

all precaution, it is impossible to prevent some of the detached grapes from partially fermenting, and this frequently has the effect of imparting a slight excess of colour to the must. The gatherings of one day are pressed the following morning, the operation being effected by means of presses of different kinds; the most ancient being the *Eliquet*, which is largely used at the present day. It is worked by a roller and grinders—large pieces of wood which are placed in layers on the pressed grapes. The grapes are spread over the floor of the press in a compact mass, only the first pressure producing a high class wine. Before beginning to press, the grapes are weighed, and 400 kilogrammes are allowed for every forty gallons of wine, and this having been obtained, no more is pressed from it for first class wine. The remainder then consists only of a heap of crushed fruit. The edges of this heap are next cut off in various ways according to the shape of the press, the edges having been subjected to less pressure than the middle. The grapes thus obtained are then subjected to a second pressure, which produces a juice called first *taille*, and this operation is repeated to get a second *taille*, and a third time for the last juice, called *redêche*, a production which, in the champagne country, is only used for the consumption of the labourers, as is also the case with the produce of the second *taille*. When the wine is flowing from the press, the juice is tested with a wine tester or glycometer, to ascertain its sweetness and the amount of sugar it contains. Then, when the wine is drawn off from the press, it is put into tubs or casks, and is left until the impurities, thrown off, have collected on the surface in the shape of a scum, called *cotte*. As soon as this scum rises to the surface, the casks are filled and vapoured by burning sulphur. This operation, setting free sulphurous acid, tends to whiten the wine and prevent the taste of oak from flavouring it. The casks are then placed in the cellar on supports, usually about eight inches above the ground, care being taken not to fill them quite full, as, when fermentation begins, they would overflow. A margin of several quarts is therefore left, and the bung is closed with vine leaves and a small tile. After a month has elapsed, and the fermentation subsided, the wine is racked off into other casks by means of copper basins and vessels. With the approach of December comes the frost, which makes the wine quite clear; it is at this period that the mixing is performed, an operation which immediately precedes the blending. The mixing consists of bringing together thirty or forty casks of the same growth. The blending, on the other hand, is the mingling of all these wines, with a view to the formation of a large quantity of wine for commercial purposes. It is at the blending time that tannin is used, in liquid or powder, to anticipate various defects in the wine, such as grease and deposits. These deposits are known in the wine district by the technical names of *marques*, *barnes*, *culs de poule*, and *lentilles*. It is at this time also that alcohol, in greater or less proportions, is added. The wine merchants find the degree of alcohol by distilling a given quantity of wine, of which they take a third, and mix the result of the distillation with some distilled water, weighing with an alcometer, and taking into consideration the degree of temperature. Champagne wines generally have from 11 to 12 per cent. of alcohol; but in some very good years, such as 1865 and 1874, as much as 14 per cent. If the year should be a poor one, and the degree of alcohol insufficient, it is remedied by adding a sufficient quantity of spirits of 82° Centigrade, made from the best Cognac brandies. The day after these operations have been completed, the fining is commenced, and this is done with isinglass, prepared beforehand with a slight admixture of tartaric acid. Every cask of white wine receives a slight proportion of this mixture, and is stirred with a stick before and after mixture, this being done with the object of thoroughly mixing the wine and isinglass. The casks are then hermetically sealed, a small hole being drilled in the top of the cask, and closed with three straws of rye or wheat, with the heads on; this admits sufficient air to remove all danger in case of fermentation. The wine remains in this state for about a fortnight or three weeks. When the wine is ready for bottling, the operation is effected by means of taps with six, eight, or ten spouts. The bottles when filled, pass into the hands of the corker—the corking being done with a mallet, and the cork secured. The bottles are then stored in the wine vaults, or left in the cellars, where they are stacked with rods and laths. In the month of July, when the bottling is over, the workmen find employment in removing defective hoops, or replacing them by new ones, and this operation, with the vintage, continue till the time of early frost. At this time many vineyard proprietors bring what they have bottled up again to the upper cellar, as the cold has the effect of helping the deposit to dry. Others simply change the position of the bottles, removing the leaky and broken ones, and making new piles. It is at this time also that attention is paid to the *masque*, the name given to the deposit on the side of the bottle, and which must be removed. This is done by means of a machine, which consists of a box, into which are placed two bottles having the deposit in them; by means of a handle a rotary motion is imparted to the bottles, which are further subjected to continued blows from two little hammers. These continued shocks produce a shaking, which is sufficient to detach the adhesive deposit. The removal, by hand, requires more attention. The workman is supplied with an iron implement, and has to be careful to hit the bottles just hard enough to detach the crust. When the bottles are entirely cleared of deposit, they are placed neck downwards, either on tables or on racks, and after being kept for some time in this position, the wine is shaken, to make all the deposit fall on the cork. This is an important operation,

and great care is taken in the selection of workmen to perform it. It is effected by very slightly lifting the bottles, and gently shaking them in that position. To bring it to a successful issue, requires a month or six weeks, or even more, the bottle being moved every day. When the deposit has altogether settled on the corks, the good bottles are placed in stacks, with their necks downwards, at a sharp angle, to await the time when they are again uncorked. The rest are replaced and worked a second time on the rack. The uncorking is also a difficult and delicate operation. It is necessary to remove the cork and wiring with the least possible loss of wine, the bottle being all the time kept neck downwards. To do this, the workman watches the bubble of air which is in the bottle, and so removes the cork that only the deposit is ejected by the rush of gas. When the froth appears, he uses a part of it to wash the neck of the bottle, and then inserts a small cork prepared for the purpose, which prevents too great a loss of gas. The bottle then passes into the hands of a man who takes out enough wine to admit the necessary amount of syrup. The wine is now very dry, and would not be drinkable; this dryness is, however, corrected by the addition of what is called the "export syrup," which differs from what is put in at the time of bottling. It is composed of 150 kilogrammes of candied sugar to every 100 litres of wine, and three quarts of alcohol added to increase the strength. As the sugar dissolves, the wine becomes thick, and must be filtered to make the liquid perfectly clear. The bottles, when opened and emptied to a certain depth, are taken to the "mixer." The mixing consists in putting into each a certain equal quantity of syrup, the precise proportion differing for each country; the bottle is then placed on a revolving table, and as it revolves, all the bottles, in turn, come to the corker. The second and final corking requires more care than the first. The corks used are made from Spanish cork, soft or strong, hard and full, or red corks, according to the country to which the wine is intended to be sent. They are soaked for a few days in cold water, before being used. For the final corking, the machine used is often a mallet machine, but others are employed. The cork is put into the tube, pressed, and made to come level with the lower end of the tube, and with a clean sponge the few drops of water which have resulted from the compression of the cork are wiped off, and the bottle is then filled and corked, the cork being driven in to a greater or less extent, according to the destination of the wine. The tying up is then proceeded with, oiled string being used. After the string is put on, the wire is attached; the kind most in use being galvanised wire. It is at this time that the bottle is shaken once or twice, to mix the syrup thoroughly with the wine. Then the bottles are arranged in piles, always on end, and are left for a month or two. In conclusion, Consul Frisbie states that to make a good bottle of champagne, at least two years of constant work and care are necessary.

THE SPONGE TRADE OF THE BAHAMAS.

Consul McLain states that, next to the pine-apple business, the trade in sponges is the most important industry of the Bahamas, bringing considerable gain to the colony, and furnishing steady and lucrative employment to several hundred vessels and several thousand persons. At first, sponges were divided into only two classes, the coarse and the fine, the former realising about twenty-two shillings a hundredweight, and the later about double that sum. They are now, however, divided into many varieties, among the best known being, "sheep wool," "white reef," "abaco velvet," "dark reef," "boat," "hard-head," "grass," "yellow," and "glove." The vessels engaged in sponging are small craft, of an average burthen of ten tons, each vessel carrying from six to twelve men. They are furnished with about six weeks' provisions, and coast along the banks and reefs where the water is shallow, and among the islands where the sponge is known to exist. The sponges are seen growing upon the rocks, reefs, and shallows, the water being particularly clear, and they are brought to the surface by means of iron hooks fastened to long poles, or by diving. When first taken up, they are found to be covered with a soft gelatinous substance, full of life, and perfectly black, the sponge proper being but the skeleton or support of this living organism. The day's catch is spread upon the deck, so as to kill this living covering, which, in decaying, emits a very disagreeable smell. When a sufficient quantity of sponge has been gathered, the boats are taken in shore, and a pen or hut of stakes is made on the beach, at the water's edge; the sponges are placed inside, when the action of the tide helps to remove the black covering, the process being completed by pounding them with sticks. Having been cleansed in this manner, the sponges are strung upon small palmetto strips, each string containing three or four sponges, being called a "bead," and with this cargo the vessel returns to Nassau. A cargo will vary from £15 to £16, according to quantity, quality, and demand. The sales and handling of the sponges are controlled by the Nassau Sponge Exchange Company, an organisation holding a charter from the colonial legislature. The company has erected a commodious building upon one of the wharves; and it is in this building that all the sponges are sold, subject to certain taxes and restrictions. As soon as the daily sale is concluded, the sponges are taken away to the packing yards, where they are assorted and clipped into good shape. They are then put into tubs or vats of lime-water to soak for several hours, and are afterwards spread upon canvas to bleach and dry in the sun. They are next pressed by machinery into bales about three feet by two feet in size, each containing 100 lbs., the packages being covered with coarse bagging, securely sewed and corded, and are then ready for shipment. All the work in connection with the sponges, from the taking to the shipment, is performed by the blacks. There has

recently been discovered, Consul McLain says, a new and extensive field of sponges near the island of Eleuthera, only sixty miles distant from Nassau; the water, however, on this new field is from five to eight fathoms in depth, and this has the effect of rendering the gathering of the sponges tedious and laborious. It is thought that the field is a very extensive one, stretching over many miles, and that the sponges are, as far as known, all of the "sheep wool," or most valuable description. The majority of the sponges found up to this time are of a very large size, and will not bear cutting to advantage, as the inner portions appear to be very tender. During three months of 1882, this field was actively worked, but a sudden interruption has occurred caused by the fact that myriads of small fish have invaded the grassy bottom, stirring up the mud to such a degree that it prevented the sponge from being seen. It is the opinion of fishermen who have been engaged for years in this industry in the Bahamas, that the sponges can only be gathered in any quantities in this field during a portion of the year, when the water is still and the fish is absent. This would detract very considerably from the value of the discovery. It appears from statistical returns of the imports and exports of the Bahamas that there is a very large increase in the annual exports of sponges, the value in 1881 amounting to about £38,000, or nearly twice as much as in 1874.

THE RELATIONS OF THE STATE TO EXHIBITIONS.

The Berlin Society for the Promotion of Industrial Activity has been discussing, at a recent meeting, the question of the regulation of exhibitions by the State. Dr. Grothe opened the debate, and confirmed his previously expressed opinion that in the German Imperial Government there should be an administrative branch for the proper carrying out of exhibitions. He also advocated a commission of Chambers of Commerce, and other corporations, which would not be controlled by the State, and would act as the representative of the mercantile community, whose participation in exhibitions would, to a certain extent, be under the control of this central authority.

Herr Delbrück, a member of the Ministry, and President of the Society, disputed the advantages which the previous speaker had considered likely to accrue from the intervention of the State in the manner indicated. He considered that, in the instances of local, provincial, and trade exhibitions, the interference of the Government would be a retrograde measure. At the same time he stated that the Home-office would willingly procure for intending exhibitors all needful information as to exhibitions abroad. While admitting the advantages resulting from international exhibitions to the countries which get them up, Herr Delbrück asked whether the gain is proportionate to the sacrifices which have to be made. He quoted the following details as illustrating, and to a certain extent answering, his question:—

	State contribution.	Proportion represented for each exhibitor.
	£.	£ s.
London, 1851	8,800	8 14
Paris, 1855	11,500	10 14
London, 1862	15,000	15 15
Paris, 1867	30,900	(No return.)
Vienna, 1873.....	156,000	25 0
Philadelphia, 1876	24,200	24 4

In view of the increasing expenses attending these international displays, and the expectations which are now formed of the scale of completeness which should be attained, he remarked that the expense of an international exhibition at Berlin would not fall far short of £1,500,000 sterling, or somewhere between the cost of the Paris Exhibition of 1867 (£920,000), and the Vienna display of 1873 (about £1,900,000.)

The majority of the members present voted against Dr. Grothe's suggestion in the division which took place subsequently.

PRIZES OFFERED BY THE SOCIÉTÉ D'ENCOURAGEMENT.

The Société d'Encouragement pour l'Industrie Nationale has arranged the subjects for the competition of 1886. The large medal, bearing the likeness of Jean Goujon, will be devoted to Architecture and the Fine Arts. The following have been the recipients of this prize:—1868 (Commerce), M. F. de Lesseps; 1870 (Chemistry), M. H. St. Claire Deville; 1872 (Agriculture), M. Boussingault; 1873 (Physics) Sir Charles Wheatstone; 1875 (Commerce), M. Jacques Siegfried; 1876 (Mechanics), M. H. Gifford; 1877 (Chemistry), Mr. Walter Weldon; 1880 (Fine Arts), M. Charles Garnier.

The Grand Prix of the Marquis of Argenteuil (12,000 fr. = £480) to the inventor or discoverer of the improvement most useful to French industry, especially for those objects in which France has not attained superiority over foreign countries, either as regards the quality or the cost of production of the article manufactured. This prize has been successively awarded, in 1846, to M. Vicat; in 1852, to M. Thoreul; in 1858, to M. Heilmann; in 1864, to M. Soral; in 1870, to M. Champonnois; and in 1880, to M. Poitevin.

Mechanical Art.—1,000 fr. (£40) for the utilisation of the power absorbed by brakes.

Chemistry.—4,000 fr. (£160) for the artificial production of fatty substances and wax.

Agriculture.—1,000 fr. (£40) for the bringing into cultivation of waste land by fruit trees.

Further information may be obtained at, and descriptions should be addressed to, the offices, 6, Place Saint-Germain des Prés, Paris.

ART INDUSTRIES IN BRITISH BURMA.

The following paper has been communicated by the Government of India :—

Of late years the art-work of the Burmese has shown signs of rapid deterioration. The wood-carvings at present executed, for instance, are not worthy of the country which can show such a wealth of exquisitely artistic work as may be seen in the older Kyoungs and Zayats of Burma. In aiming at cheapness and utility, beauty and good taste have too often been sacrificed. The cause of the decadence appears to be traceable to the greater development of commercial energy. The struggle for existence among the mass of people is getting keener, and the love of money is greater, than formerly. The wealthier Burmese spend less on purely religious edifices, and the artisans push through their work quicker and look more to pecuniary reward than their fathers did.

To counteract this decadence, and foster and encourage the native talent in art-work, and to assist in applying it to modern requirements, an association, called "The Institute of Industrial Art, British Burma," has been formed, with the approval and support of the local Government. The Institute consists of a permanent committee of direction, and of a guild or guilds of workmen, or of individual producers of industrial art-objects who may be benefited by association with the Institute.

The Committee has the power to extend itself, by invitation to persons interested in actively furthering its objects, and it may, when established in working order, invite the assistance of visitors or patrons of art who may approve of the purposes of the Institute. For the present the committee of direction consists of—

Mr. R. Rowett, of Rangoon, Chairman.

Mr. D. M. Smeaton, M.A., Secretary to the Chief Commissioner, Land Revenue and Agricultural Department, Treasurer.

Mr. R. Gordon, M.I.C.E., F.R.G.S., &c., Secretary.

The committee, as constituted, has taken over the art-furniture business of the Rangoon and Moulmein jails, and will endeavour to graft on this the higher art industries of wood-carving existing in Henzada and elsewhere in Burma, placing the whole on a co-operative basis, where the workmen will be paid, in the first place, the net cost of the work produced, and afterwards, at regular intervals, quarterly, half-yearly, or yearly, as shall be most expedient. The profits proceeding from the sale of the articles shall be divided, so that four-fifths shall be distributed to the workmen, and one-fifth shall remain at the disposal of the committee of direction.

To this one-fifth the local Government of British Burma will add an equal amount guaranteed for five years, and the sum thus obtained is to be devoted to the furtherance of art purposes, in offering prizes for objects of high or of useful art, in giving certificates of proficiency or excellence to art-workers, in publishing from time to time illustrative selections from the most worthy productions, or in such other modes as shall be deemed expedient for the purposes of the Institute.

The Institute will at first take up work connected with wood-carving; but it will eventually extend the field of operations to all branches of art where native talent can find employment. Gold and silver work, tin, copper, and brass work, ivory-carving, gilding, colour decoration, embroidery, &c., will be taken up, and, it is hoped, find encouragement and support by help of the Institute.

There are several artists of genuine talent in British Burma, who execute graceful and quaint designs in metal, but who do not know where to apply to get orders for their work. Then, again, as regards the designing of patterns and colours for textile manufacture, it is acknowledged that some of the designs are very beautiful, and the exquisite innate sense of the Turanian race for colour and form find scope for display, even in the restricted local demands for their work. It is possible that a wider knowledge of the capabilities of the Burmese may open out new fields for outline and colour decoration.

At present, book-stands, what-nots, shelves, screens, &c., in wood-work are made to order under the direction of the Institute. Prices and further information will be supplied on application to "The Manager of Workshops, Institute of Industrial Arts, Rangoon."

THE CULTIVATION OF FLAX IN THE UNITED STATES.

According to the *Moniteur des fils et Tissus*, a report on the above subject has been sent to the French Government by its Consul at New York, from which it would seem that the cultivation of flax (which was almost unknown in the United States at the commencement of the present century) has of late years acquired a certain importance. There are now more than a million acres devoted to flax-growing in various parts of the Union, Iowa occupying the leading position with about 300,000 acres, Indiana following with about 200,000, while Illinois and Kansas each furnish about 160,000 to the total. Ohio, Minnesota, Wisconsin, Missouri, and Nebraska, show a joint total of about 320,000 acres. From this extent of land under cultivation, it would at first sight seem that the production of flax is sufficient to meet the domestic requirements of the

Union; but it is remarked that the inexperience of the growers, and the inferior quality of the seeds used, have combined to limit the advantages which might be derived from this abundant culture. An authority on the subject has stated that farmers owning 450,000 acres are obliged, for the want of suitable outlets for the fibre, to burn it, and only to preserve the seed. The protection afforded by the tariff to the domestic industry has to be considered; and it is further asserted that two large Irish firms, who have recently established factories in New Jersey, are obliged to import the bulk of their requirements of the raw material.

The cause of this state of things has been attributed to the low price to which native American flax was driven, when the reduction of the jute tariff opened the American markets to large imports of the Indian fibre. The indigenous article would seem to have been employed at one time rather extensively in the manufacture of bags and of coarse tissues. The circumstances alluded to brought about a depreciation of value, which has discouraged farmers from giving the needful attention to the much-needed improvement of flax-culture.

It is suggested that, if a proportion of the immigrants now arriving on the shores of America were to be put in the way of growing flax instead of wheat, &c., there would be more chances of success for those who have already been giving their attention to cereals. In this way, it is remarked, an improved quality of flax might readily be acclimatised in the Union, and, under the climatic advantages it enjoys, the New World might be reasonably expected to produce those supplies which have now to be imported.

Correspondence.

EGYPT.

Having been prevented from attending on Tuesday last to hear Mr. Felkin's paper, I beg to offer a few remarks on one or two points to which, had I been present, I should have drawn attention. The first is the reference to the Suez Canal and the alternative scheme of the fresh water canal. Having so lately, in my paper read before the Society, as well as in my pamphlet, entitled "The Highway of Egypt," pointed out the inexpediency of that scheme, I should not revert to it again, but for the reference which the reader of the paper made to the proposed Manchester Canal, stating that if locks are to be employed in the construction of that work, why should exception be taken to their use on the Egyptian ship canal. There is little or no analogy between the two works. The one is a short canal for the purpose of obviating the expense of transhipment to an inland city in England, the traffic to which must necessarily be limited. The other is a line 240 miles long, to provide for the entire trade between the eastern and western nations of the world, and may be said to be comparatively unlimited. An accident to the locks on the one would not lead to a total suspension of the traffic, as it could be taken up again by the routes at present in use. A stoppage in the other would lead to the utmost confusion and derangement. For the Suez Canal, left in the hands of the existing proprietary, would be virtually closed to English trade, as the Canal Administration could scarcely be expected to allow their highway to be used merely as a convenience for British commerce, without exacting far more stringent conditions than are even now imposed.

For supplying irrigation, and providing for inland traffic, the existing lines of canal in the Delta can be rendered efficient at a comparatively small outlay. Mr. Felkin has evidently been misinformed as to the sum required to make the Barrage capable of the purposes for which it was designed, and no proper or effective scheme of perennial irrigation throughout the Delta is feasible until it, or a weir of some kind, is built across the Nile, and the level of that river raised during its low stage. This is a point which existing systems of Delta irrigation have placed beyond the scope of argument.

The public are much indebted to Mr. Felkin for the extremely interesting and valuable information which he has furnished regarding the capabilities of the Soudan and the Equatorial possessions of Egypt, and there can be little doubt but that opening communications between those provinces and the seaboard will, in time, be followed by an extensive and profitable trade. That more than 1,000 miles of river are already traversed by steamers above Khartoum is a most important fact, and the little work that is seemingly required to connect those lines, and to overcome intermediate obstacles, *must*, ere long, form a subject for investigation.

The conclusion, however, at which Mr. Felkin has arrived, that a railway, from Berber on the Nile to Suakim on the Red Sea, is the most desirable mode of opening up the trade of the Equatorial districts, seems to be singular as far as any benefit to the Egyptian Government is concerned. The most obvious route for produce, which has once been shipped on steamers on the highest point of the Nile, and its several affluents named in the lecturer's paper, is surely along that great river itself; and the port of shipment must be, not Suakim, an obscure town on the uninhabitable coast of the Red Sea, but Alexandria, the great port of Egypt in the temperate climate of the Mediterranean, the present rendezvous for the fleets of all nations, where not only every facility for shipment at present exists, but which,

notwithstanding the Suez Canal, must inevitably regain its ancient renown as one of the must important maritime cities of the world.

F. H. RUNDALL,
Lieut.-General, C.S.I., R.E.

March 5, 1883,

CHEMICAL ANALYSIS OF DRINKING WATER.

The steps taken by the United States Board of Health, referred to in an article in the *Journal of the Society of Arts* (see *ante* p. 215), and which have for their object the determination of the relative value of the several methods employed in the analysis of drinking waters, are well deserving the notice of the Local Government Board of this country. The divided opinions of chemists at the present moment serve only to confuse, mislead, and unsettle the public mind. Some effort will surely be made by the new President of the Local Government Board to put an end to the scandal engendered by the monthly publication of two or three chemical analyses of the water supplied to London, which are not only directly contradictory, but are often apparently intended to discredit each other.

Although it is uncertain when the question of a pure water supply will form the subject of discussion in Parliament, it nevertheless continues to occupy the attention of all classes of intellectual and intelligent men both at home and abroad. As an evidence of this, I would refer to an interesting discussion, extending over two or three ordinary meetings of the Institution of Civil Engineers. The paper which originated the discussion was one on "The Antwerp Water Supply." It appears that the inhabitants of this town had for years drawn their water supply from shallow wells, most of which were polluted by neighbouring cesspools, and it was therefore thought desirable to bring in a better and safer supply. It was proposed to draw the future supply from the River Nethe, but the great obstacle to carrying this into effect was that the water is so turbid and muddy that no ordinary method of sand filtration would render it clear enough, that is, remove the suspended organic and mineral matters. The inhabitants of Antwerp preferred their polluted well waters—which were clear and sparkling to the eye—to the dirty-looking, unpalatable, river water of the Nethe. Subsequent trials made with spongy iron as a filtering material proved to be more successful, and ultimately the water was, in appearance at least, so much improved, that three eminent chemists to whom it was submitted certified to its efficient filtration, and also averred that this filter "possessed the power of destroying organic impurities and destroying the germs of putrefaction, of bacteria, and probably those of epidemic diseases."

This remarkable statement deserves somewhat closer scrutiny, and the natural inquiry is, what is spongy iron? Spongy iron is iron prepared by reducing hæmatite ore at as low a temperature as possible, by means of carbon. The ore not being submitted to as high a temperature as is the case in the ordinary blast-furnace, the resulting metal is not homogeneous in structure, is vesicular and spongy, and can be easily broken up. Its action over water is said to be chemical, not mechanical. It exerts a reducing action, diminishing the quantity of organic carbon and nitrogen. It undoubtedly has a deoxidising effect npon water, and for this reason it has been found necessary, after passing water through spongy iron, to send it once more through a layer of sand. It is also said that the spongy iron employed in filtration in no way deteriorates—that is, so far as can be determined by the filter beds which have been in use for eighteen months. A remarkable property in itself, no doubt.

I have experimented with a house filter, and find some of the statements in no way borne out; with regard "to the complete destruction of bacteria and their germs," this is certainly not a fact. On submitting a number of samples of spongy-iron-filtered water to Dr. Koch's gelatine process and the microscope, I have had ample proof of the presence of myriads of living bacteria. It is not pleasant to chemists to have their results questioned and their analyses pronounced worthless, but as this is a matter which greatly concerns the public health, the truth should be told. It is but fair to say that, as my experiments proved to be unfavourable to spongy iron, the supporters and advocates of this material question my results. It is urged by them that the outer air was not carefully excluded, and, therefore, that the water became infected after it was drawn from the filter, or that some infective germs had obtained access to my test tubes, and so forth. My answers to objectors on these grounds is simply that it is a part of the filtering process as pursued at Antwerp, to expose the water, after it has passed through the spongy iron, freely to the air before it is delivered to customers; and, furthermore, that samples of pure distilled water submitted at the same time, and under exactly the same conditions, to the gelatine process, show no sign whatever of any change. The gelatine test must, therefore, I think, be accepted as conclusive.

The results obtained by Koch's gelatine process are, to a great extent, palpable to the naked eye, and indisputably show the comparative vital activity of the organisms contained in each specimen of water examined; and in such a way that they can be photographed, and made a perfect record of the intensity of life in the liquid. The microscope subsequently employed removes every doubt, and enables us to designate the genus and species to which organisms may belong. In a little time I hope we shall have accumulated sufficient evidence of the fact that this mode of examining water is far more im-

portant to the profession and the public than any mere chemical analysis.

JABEZ HOGG.

1, Bedford-square.

PREVENTION OF FIRES.

Mr. John George Barry sends a copy of a letter which he addressed on the 10th November, 1870, to the then Secretary of State for the Home Department, the Right Hon. H. A. Bruce, M.P. (now Lord Aberdare), and a series of "Suggestions for securing an official and scientific inquiry into the causes and extent of fires throughout England, and for preserving a Government record of the same, for periodical submission to Parliament." He encloses these in a letter, in which he alludes to the coincidence of argument between these suggestions and the paragraphs in Mr. Walford's paper where the collection of systematic records of destruction of property by fire is urged.

Notes on Books.

ENSILAGE IN AMERICA; its Prospects in English Agriculture. By JAMES E. THOROLD ROGERS, M.P. London: W. Swan Sonnenschein and Co. 1883. Small 8vo.

Professor Thorold Rogers, who read a paper on Ensilage before the Society of Arts on the 31st of January last (see *Journal*, vol. xxxi., p. 229), has now published his work on the same subject. The practice of storing ripe corn in air-tight and water-tight subterranean pits has prevailed for many centuries, and the practice was commenced in order to protect produce from marauders. It has been applied to green crops for some years in France, and it was the translation and publication in New York of M. Goffart's work on the subject which first attracted the attention of the American public. In January, 1882, the United States Commissioner of Agriculture at Washington sent out a circular containing 26 practical questions, relating to the practice of ensilage, and he received ninety-one sets of answers. Mr. Thorold Rogers gives an analysis of the results elicited by these replies. He also gives a chapter on the adoption of ensilage in the United Kingdom, and expresses the opinion that as in the United States the chief crop which is preserved in silos is maize, so, if the practice becomes at all general in England, he believes that maize will be more generally grown here.

ENSILAGE: a System for the Preservation in Pits of Forage Plants and Grasses independent of Weather. By Thomas Christy, F.L.S. London: Christy and Co. 1883. 8vo.

Mr. Christy has gathered together a large number of opinions on the value of preserving green forage plants in silos, and gives information as to the various forms in which these pits may be made, one of the cheapest being that which is placed at the side of a hill. This pamphlet contains a report of the American Ensilage Congress in 1882, and a number of illustrations.

HARNESS AS IT HAS BEEN, AS IT IS, AND AS IT SHOULD BE. By John Philipson; with Remarks on Traction, and the use of the Cape Cart, by Nimshivich. Newcastle-upon-Tyne. London: E. Stanford. 1882. 8vo.

The author treats first of what harness has been, and shows how the ancient Assyrians, the Greeks, and the Romans harnessed their horses to their chariots. Passing down to modern times, he quotes from the famous Duke of Newcastle, who wrote on the *manège* in the seventeenth century, and then comes to the main object of his book, the description of harness as it is, and as it should be. The mode of preparation of leather is explained, and the need of keeping this material clean and supple is insisted upon. The various items that go to make up the furniture are described, and the relative advantages of German silver, nickel, and other metal are discussed. The appendix contains directions to coachmen, and hints on driving. This book is fully illustrated, and, besides plates of harness, carts, &c., contains cuts by Thomas Bewick, printed from the original wood blocks.

General Notes.

CORK EXHIBITION.—The time allowed for applications for space in this Exhibition, to be opened in July next, has been extended to the 17th March.

INTERNATIONAL EXHIBITION AT CARACAS.—An international exhibition is announced to open at Caracas, Venezuela, on the occasion of the centenary of the birth of Simon Bolivar, the Liberator, which falls in the present year.

HORTICULTURAL EXHIBITION AT ST. PETERSBURGH.—An International Horticultural Exhibition and Botanical Congress is arranged to be held at St. Petersburgh in the course of the present year.

MINERALS IN COCHIN CHINA.—It appears from the explorations of M. Petiton, who has presented to the Paris Society of Civil Engineers his geological map of Cochin China, that the colony contains gold and silver, iron ore, lignite, and phosphate of lime.

CALCUTTA EXHIBITION.—The new buildings for the International Exhibition are being erected next to the Imperial Museum, under the superintendence of Col. the Hon. S. T. Trevor, R.E. Invitations have been sent throughout India to all the rajahs

and princes, inviting them to contribute to the Indian display, which is expected to be on a very grand scale.

Utilisation of Pyrites Refuse for Steel-making.—Experiments are now being made at the Terre-Noire Works for uitilising the residue of iron pyrites. Briquettes are made with the pyrites conglomerated with hydraulic lime; and, by simple exposure to the atmosphere, an ore is obtained which is said to yield an excellent steel. The sulphur is believed to be completely eliminated by the lime, and there is no phosphorus. The company have large banks of pyrites refuse that they have hitherto been unable to utilise.

Agricultural Lectures.—The Institute of Agriculture has arranged for the delivery of a course of lectures on "Agricultural Science," in the Lecture Theatre of the South Kensington Museum, on Monday evenings, from March 5th to April 30th. The lecturers are Mr. W. Carruthers, F.R.S., Prof. J. Wrightson, Mr. F. Cheshire, Prof. J. Buckman, Prof. J. P. Sheldon, Mr. R. Warington, Prof. W. Fream, and Miss E. A. Ormerod. An examination will be held at the conclusion of the course of lectures.

Elphinstone and Vincent Dynamo Machine.—Some experiments with the dynamo machine by Lord Elphinstone and Mr. Charles W. Vincent, were made on the evening of Wednesday, February 21st, at the printing-office of Messrs. Unwin Brothers. A warehouse was lighted by 350 Swan incandescence lamps, each of 20-candle power, and Lord Elphinstone explained that the machine was capable of driving 416 Swan lamps. The experiments were conducted by the lighting up of a "Search Light," as used in the Navy—the carbons of which are $1\frac{1}{4}$ inches in diameter, capable of giving a light equal to 100,000 candles. The motive-power used for driving the dynamo machine was supplied by one of Rigg's patent high-speed engines, capable of developing 60 indicated horse-power, and the mechanical arrangements were carried out by Mr. Arthur Rigg.

Flaxman and the Society of Arts.—At the sale of the drawings and remaining works of John Flaxman, R.A., by Messrs. Christie, Manson, and Woods, which took place at the beginning of last week, there were sold two honorary pallets in silver gilt, presented by the Society of Arts to Flaxman, at the ages, respectively, of eleven years five months, and thirteen years; these, which were in one lot, fetched eleven guineas and a half. There were also a gold pallet, presented by the Society to Flaxman in 1770 for a a basso relievo in clay, which sold for eleven guineas, and the presentation gold medal to Flaxman in 1807 for his design of the medal, which brought eight guineas and a half. The premiums awarded to Flaxman by the Society of Arts were:—1766, ten guineas for a figure of Minerva; 1769, ten guineas for bas relief of the death of Julius Cæsar; and silver medallion for bas relief of the death of Cleopatra; 1770, gold pallet for a whole length figure of Garrick; 1807, gold medal for the design of the Society's new medal, modelled and presented by him. Flaxman continued his connection with the Society of Arts throughout his life, and acted as chairman of the Committee of Polite Arts.

Blast Furnaces.—It would appear from the published returns that there were 963 furnaces built last year, against 968 in 1881, whilst 575 were in blast in 1882, against 555 in the previous year. The greatest increase in the number of furnaces in blast was in Scotland, when 113 out of 148 built were in blast, against 105 at work in 1881, an increase of five furnaces. Cleveland shows an increase of four on the year, 100 being at work, against 96, but there was a decrease of three furnaces built last year, as compared with 1881. East Worcestershire had also an increase of four, 50 being in blast, against 46 in 1881; but there was a decrease of five furnaces built. In Glamorganshire there was also an increase of four furnaces blowing, so that the districts named furnish the whole of the increase. The chief changes in other districts were a falling-off of four in the north-east and north-west of England. The returns of the furnaces built in some districts scarcely convey a correct idea. Some of the old furnaces, although in existence, will never be worked again, as they cannot now be worked at a profit in competition with new forms.—*Engineer.*

The Textile Industry of Russia.—According to an official report, there were, in 1881, no less than 2,838 establishments in Russia engaged in the various operations of the textile trade and its allied industries. They are classified as follows by the *Central Blatt für Textil-Industrie*:—

	Number of Workpeople.	Value of Annual Productions.
		£
Silk weaving 163	880	1,300,000
Cloth manufacture 746	95,990	11,000,000
Carded yard spinning..112	8,140	2,250,000
Cotton spinning 76	101,300	11,750,000
Mixed yarn spinning ..293	29,950	5,500,000
Cotton weaving 640	85,000	15,750,000
Calico printing.....313	27,000	6,250,000
Flax heckling 62	1,090	650,000
Rope hemp spinning ..323	73,014	1,050,000
Flax spinning 36	26,850	2,500,000
Linen weaving..... 74	14,150	1,600,000

Boracic Lagoons of Italy.—A report upon the springs in the Province of Pisa, which yield boracic acid, has recently been issued by the United States Consul at Leghorn, from which it appears that the district in which the springs occur belongs entirely to one owner, the Count de Lardarel, who possesses seven "borax" villages. The most abundant supplies are obtained from artesian wells, which invariably strike the borax vein at a short distance from the surface. The boring, however, is carried

down until the well yields water, when the machinery is withdrawn and water let into the shallow pond previously dug around the bore hole. This water very soon becomes heated up to boiling point, and impregnated with the borax, which rushes up from the opening of the artesian well, after which the water is drawn off and evaporated by passing it over a series of shallow metal pans, from fifteen to twenty in number, arranged like a cascade. The borax as it reaches the bottom pan is half solidified, and when cold has the appearance of being frozen over with a skin of rotten ice. This skin is removed and strewed on the floor of a drying-house heated by hot pipes, and by this means the borax becomes crystallised. The lagoons have a most peculiar aspect during the issuing of the borax. When full of water the boiling is continuous, rising to some feet in height, but the vapour is quite clammy and unpleasant from its sulphurous odour. The smell of sulphur, indeed, pervades everything about the establishment, and everything in the shape of metal is greatly affected. The brass instruments of the workmen's band are coated with it for a tenth part of an inch; silver watches look more like platinum than silver; and only gold of the purest quality keeps its colour. The quantity of borax produced from the estate averages from three to three and a half tons a day, but as this is only one of the borax villages (though the most profitable), the total yield may be put down at 11 tons per diem. Upwards of 1,800 labourers are employed on the property, of whom 800 are exclusively engaged in the production of the acid.

Life Saving Apparatus.—A letter from Mr. John Wilks, President of the Victorian Humane Society, on this subject, was lately printed in the *Daily News*. The writer says that before he left Melbourne, the present Government had prepared a Bill to deal with the subject on the basis of the following "suggestions" which were submitted by the society after they had been settled and approved by a committee of shipowners and masters and marine surveyors, viz.:—"That the Passengers, Harbours, and Navigation Statutes should be amended in the following particulars:—That the provisions regarding the number and capacity of boats to be carried by steamers should be based upon the maximum number of passengers and crew allowed to be carried, and not upon the tonnage of the ships, and should require that a larger proportion of such boats should be lifeboats, and fitted with the most approved patent lowering apparatus. That more stringent provision be made with respect to the keeping of such boats in a position and state fit for immediate use. That in the case of ships carrying more than 150 passengers, life-rafts, or other apparatus, in addition to boats, should be carried. That the number of life-buoys to be carried on board ship should be regulated by a scale, according to the number of passengers and crew allowed to be carried by such a ship. That a clause should be inserted, requiring the master of every ship to provide a life-jacket for every passenger and sailor allowed to be carried, and that such life-jacket should be placed inside each berth. That proper provision be made that sailing ships carrying passengers should be provided with fire-hose and distress signals. It is most desirable that the Imperial law should be amended in the same direction, so that the laws of England and the Colonies may be identical." Mr. Wilks says, further, with regard to the report of the Committee of the Society of Arts "Some time ago this matter was considered by the on this subject (see *Journal*, vol. xxvii., p. 298), Council of the Society of Arts, and a most valuable report was submitted by a special committee, including Admirals Ommanney, Ryder, and other distinguished gentlemen."

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

March 14.—"The Development of Irish Industries." By John Caldwell Bloomfield.

Papers for Reading after Easter.

"Electricity as a Motive Power." By Prof. George Forbes.

"English and Foreign Silver Work; with Some Remarks on Hall-markings. By Wilfred Cripps, F.S.A.

"Economy of Sanitation." By Capt. Douglas Galton, C.B., F.R.S.

"Technical Education in connection with Intermediate Schools." By Philip Magnus, B.Sc., B.A.

Foreign and Colonial Section.

Tuesday evenings at Eight o'clock:—

March 20.—"Social and Commercial Aspects of New Zealand." By William Delisle Hay. Sir Charles Clifford will preside.

April 3.—"The Trade Routes of Persia." By Col. Bateman Champain, R.E.

Applied Chemistry and Physics Section.

Thursday evenings at Eight o'clock:—

March 22.—"Self-Purification of River Waters." By W. N. Hartley, F.R.S.E. Prof. Abel, C.B., F.R.S., will preside.

April 12.—"The Formation of Diastase from Grain by Moulds." By R. W. Atkinson, B.Sc.

Indian Section.

Friday evenings at Eight o'clock:—

April 6.—"Historical Development of the different Settlement Systems of British India." By W. G. Pedder.

April 20.—"Fisheries of India." By Surgeon-General Francis Day.

MAY 4.—"Some Notes on the Domestic Architecture of India." By C. PURDON CLARKE.

CANTOR LECTURES.

Monday evenings at Eight o'clock:—

Third Course, on "The Decorative Treatment of Metal in Architecture." By G. H. BIRCH, Assoc.Inst.B.A.

April 2, 9, 16.

Fourth Course, on "The Transmission of Energy." By PROF. OSBORNE REYNOLDS, F.R.S.

April 23, 30; May 7.

Fifth Course, on "Secondary Batteries." By Prof. OLIVER J. LODGE, M.A., D.Sc.

May 21, 28.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 12.. Society of Engineers, 6, Westminster-chambers, 7.30. Mr. A. T. Walmisley, "Land Surveying and Levelling." (Lecture VIII.)

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. E. Delmar Morgan, "Mushketof's Exploratio of the Zarafshan Valley and its Glacier."

Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Professor J. Wrightson, "Conditions Influencing Land Drainage."

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. R. A. Proctor, "The Great Pyramid."

TUESDAY, MARCH 13...Royal Institution, Albemarle-street, W., 3 p.m. Professor R. S. Ball, "The Supreme Discoveries in Astronomy." (Lecture IV.) "The Astronomical Significance of Heat."

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion' on Mr. Ralph Hart Tweddell's paper, "The Productive Power and Efficiency of Machine Tools, and of other Labour-saving Appliances worked by Hydraulic Pressure;" and (2) on Mr. Alexander McDonnell's paper, "Stamping and Welding under the Steam Hammer."

Photographic, 5a, Pall-mall East, S.W., 8 p.m.

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. H. O. Forbes, "Report on the Ethnology of Timor-laut." Communicated by the Committee of the British Association, throngh Mr. John Evans. 2. Mr. Gustav Oppert, "The Classification of Languages."

Royal Colonial, the Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Sir John Gorrie, "Fiji as it is."

WEDNESDAY, MARCH 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. C. Bloomfield, "The Development of Irish Industries."

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m. Dr. C. T. Hudson, "A Batch of New Floscules."

Institution of Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), 12. 1. Annual Report of Council. 2. Election of Officers and the Council. 3. Address by the President. 4. Reading and Discussion of Papers.

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m. Annual Meeting.

Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Lumleian Lectures.) Dr. A. B. Garrod, "Uric Acid in its relation to Renal Calculi and Gravel." (Lecture II.)

THURSDAY, MARCH 15...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Institution of Naval Architects (AT THE HOUSE OF THE SOCIETY OF ARTS), Morning Meeting, 12. Evening Meeting, 7. Reading of Papers and Discussion continued.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. T. Spencer Cobbold, "Simondsia Paradoxa and Sphaerularia Bombi." 2. Mr. A. G. Butler, "Moths of the Family Urapteridæ." 3. Rev. R. Boog Watson, "Mollusca of *Challenger* Expedition." (Part 18)

Chemical, Burlington-house, W., 8 p.m. Mr. F. E. Matthews, "Some Condensation-Products of Aldehydes with Acetoacetic Ether and Substituted Acetoacetic Ethers."

London Institution, Finsbury-circus, E.C., 7 p.m. Professor W. E. Ayrton, "Electric Lighting and Locomotion." (Lecture II.)

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. J. W. Bradley, "The Ornamental Art of the Italian Renaissance."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Spectroscope and its Applications." (Lecture IX.)

Royal Historical, 22, Albemarle-street, W., 8 p.m.

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. H. M. Whitley, "The Reclamation of Land."

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Dr. C. William Siemens, "The Electrical Transmission and Storage of Power."

FRIDAY, MARCH 16 ... Royal United Service Institution, Whitehall-yard, 3 p.m. Professor F. A. Abel, "The Most Recent Progress in the Production and Application of Explosive Compounds."

Institution of Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), Morning Meeting, 12. Evening Meeting, 7. Reading of Papers and Discussion continued.

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Professor Tyndall, "Thoughts on Radiation, Theoretical and Practical."

Philological, University College, W.C., 8 p.m.

Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Lumleian Lectures.) Dr. A. B. Garrod, "Uric Acid in its Relation to Renal Calculi and Gravel." (Lecture III.)

SATURDAY, MARCH 17 ... Geologists' Association, British Museum (Natural History), South Kensington, S.W., 2½ p.m. Demonstration by Professor L. Fletcher on "Crystals."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. Statham, "Music as a Form of Artistic Expression." (Lecture II.)

Journal of the Society of Arts.

No. 1,582. Vol. XXXI.

FRIDAY, MARCH 16, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

MINERS' SAFETY LAMP.

Mr. Ellis Lever has offered a prize of £500 for a new miners' safety lamp, and has requested the Council of the Society of Arts to appoint one of the judges to award the prize. In accordance with this request, the Council have appointed Professor F. A. Abel, C.B., F.R.S.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1883, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce." The following is a list of those to whom the medal has already been awarded :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (now Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c.

In 1870, to Ferdinand de Lesseps.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (now Sir) Henry Bessmer, F.R.S.

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin.

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

A full list of the services for which the medals were awarded was given in the last number of the *Journal*.

The Council invite members of the Society to forward to the Secretary, on or before the 21st of April, the names of such men of high distinction as they may think worthy of this honour.

Proceedings of the Society.

INDIAN SECTION.

Friday, March 2nd, 1883; the Hon. Sir Ashley Eden, K.C.S.I., in the chair.

The paper read was—

AGRICULTURE IN LOWER BENGAL.

By W. S. Seton-Karr.

I must request my hearers to bear in mind that the subject of my paper is not agriculture in India, or even the Bengal Presidency, but in Lower Bengal, and more particularly in those large, fertile, and populous districts in the neighbourhood of Calcutta, which may be termed metropolitan. I may, occasionally, just refer to the features of western Bengal, where the alluvial plain ceases, and the land undulates; but my remarks will have mainly reference to such well-known and level plains as are comprised in the districts of Nuddea, Jessore, Pabna, Hooghly, and the twenty-four Pergunnahs. None of my remarks must be taken to apply to the Doab of Hindostan, or even the Provinces of Behar and Orissa. I will assume that most of my hearers are aware

of the fact that these districts of Lower Bengal are entirely made up of alluvial deposit. No such thing as a natural or indigenous stone is to be picked up in any one of them. The ordinary roads, made by magistrates and engineers, are composed of burnt brick, and the very streets of Calcutta are paved with grey stone brought as ballast from the Mauritius. The soil of the Gangetic Delta has been created by silt brought down, in the course of centuries, from a network of rivers; and it may be doubted whether, in the whole of our Indian Empire, there exists land more productive or more fitted for the labour of the agriculturist than in Bengal Proper.

Now, this land may roughly be divided into three different sorts, for it is scarcely necessary to remind you that, before entering on a description of the staple produce of the country, the varying nature of the land ought to be considered. The ryot himself is accustomed to designate the soil as, first, *mattial*, from *mati*, the earth, which practically is thick, viscous, tenacious clay. This earth, in the rainy season, becomes a quagmire, in which carts stick and beasts are impounded. In the dry season, from November to May inclusive, it presents a surface almost as hard as rock, on which neither plough nor mattock can make the smallest impression. The second kind is known as *doas;* a rich loam with an admixture of sand. The third is *balu*, or pure sand, which absorbs moisture, rapidly pulverises, and can be most easily traversed by cart and bullock, by palanquin or passenger, after heavy rain. Or, again, the lands may be classed analogously in another wider and three-fold division. The first comprises the vast plains which periodically suffer from the inundation of large rivers, such as the Poddha, or Ganges Proper, the Gorai, the Kumar, the Damudaha, Rup Narayan, and others. The second division of this category comprises these low levels or depressions which are beyond the reach of the Ganges or its tributaries, but, from their clayey soil, hold water like a cask, and never dry up till the crops have been reaped and carried, and the cold season has given way to the heats of March and April. The third sort is the high, dry, and sandy tract which is never affected by stream or river, and which rapidly absorbs or throws off any amount of rain. The ordinary ryot makes two divisions only, and is familiar with the expressions *denga mulk*, a dry country; or, *jola mulk*, a low and wet country.

Bearing in mind this triple division of the earth itself, or of the plains with relation to the inumerable rivers and streams of the Delta, and also recollecting that the rainfall over a large portion of Bengal may be taken at 65 to 75 inches a year, we now come to the produce which is raised in the districts already enumerated. I should add, that the rainfall is heaviest towards the eastern, and lightest in the western districts of Bengal; and that, whereas in Tipperah and Chittagong, it may nearly average 100 inches, in Bancorah and Beertbhum it may fall to 50 or 60 in the year. But, for practical purposes, in an ordinary year it could be safe, in Jessore and Nuddea, to put it as 65 or 70. All of you are aware that rice is the staple production of Bengal. Indeed, so prevalent is this notion, that erroneous deductions have been made as to the necessity of this article of food for all Hindoos anywhere. The inhabitants of Upper India live on wheat, *joar*, or *bajra;* and though in Behar some castes are said to make one meal in the day of rice, it is in Bengal Proper that this article is most widely cultivated and universally consumed. The late Mr. Buckle fell into the mistake of basing an estimate of the qualities of natives of all India on the assumption that they all were brought up on rice.

Of this cultivation there are three main varieties well and widely known over the whole of Bengal. They are called respectively the *aoos*, the *aumon*, and the *boru*, terms which late famines have made familiar to a wide circle. Philologists have busied themselves, not improperly, in deriving these terms from the Sanskrit, as follows:—*Aoos* is a contraction from *Ashuvrihi*, the quick growing; *Aumon* means *Himanta*, the season of cold; and *Boru* is thought to be a corruption of Varuna, the Indian Neptune, or Regent of waters.

I shall take the Aoos crop first. In the month of March, or April at latest, the ryot, as well as the Mahajan and the indigo planter, look anxiously for a sowing shower; for rain, in short, which, without flooding the land, will drench and resolve it sufficiently to allow of agricultural operations, and will bear the next few days that sufficient amount of moisture which the Ryot is accustomed to designate by a term not found in the dictionaries, or *Jo*. The Aoos is grown on high and sandy localities. If it is sown in March or April, it is usually cut in August or September. Once or twice in my experience I saw a crop

of this kind cut as early as the very last day of July; and now and then I have noted a field of Aoos uncut in the first days of October. But, roundly speaking, the Aoos is sown, grown, and reaped in about 100 or 110, or 120 days. It does not need to have its roots in water, like other varieties; it requires a succession of showers to keep it moist; but from its mere position, it is never ruined by disastrous inundations; and though its returns are smaller, its stalks less than, its grain inferior to, the Aumon crop, it is a universally serviceable product, and in ordinary seasons a reliable crop. Less rent is invariably demanded for lands sown with Aoos. It comes in early in the season, to enable the cultivator to pay his landlord, or to discharge the debt due to the Mahajan, or what in Ireland would be called the gombeen, and, as I shall show presently, it leaves a considerable portion of land at the close of the rainy season free for the cultivation of what in Bengal is known as the cold weather crop.

The Aumon, or winter crop, is the next great division. I must guard myself and others against the mistake of supposing that two crops of rice are grown anywhere on the same piece of land in the same year. In all my experience and inquiries, I never knew this to occur but once, and this local exception, of course, proves the universal rule to be the other way. I find that I saw a man cut the Aoos on the last day of July, and plant the same piece with Aumon three days afterwards. Aumon is grown in depressions, in vast plains which extend for miles, which separate populous villages, which for six months in the year are often impassable for pedestrians unless they can pick their way along the slender embankments which divide the fields, and which, from July to October, are deep in water, and are constantly traversed, rice crop and all, by light *doongas* or *Saltis*. In a general way, it may be said that the Aumon requires from five or six months to ripen for the sickle. The harvest will vary according to the level of the ground, and not according to the climate. In stiff clay, but not in the lowest depressions, this crop may be sown in June, and cut towards the middle or end of November. It is, perhaps, most correct to say that the Aumon harvest occupies the months of December, January, and February. I have seen the reapers at work as late as March—I have even known them begin by the 10th of November. In very low-lying lands—known everywhere as bheels or jheels, *Anglice*, marshes—the ryot has no sooner cut his winter crop, than he begins to think about preparing his soil for next year. As the Aumon is much heavier, richer, more paying than the Aoos, so it is more exposed to the fluctuations, caprices, and irregularities of the seasons. It is really the most important crop of the year. If too much rain falls in April or May, the ground cannot be got ready for the plough until heavier showers come down in a ceaseless deluge, flood the low soil in June, and prevent work. If little or no rain falls in these spring months, a stoppage of work equally ensues. Perhaps the best years are those in which the land can be ploughed by timely rains in May; the seed sown broadcast in that month, to be fed by continuous but not too heavy showers in June or July. In very deep levels, ploughing operations can be got through on the strength of the moisture left by last year; that is to say, I have seen the winter crop cut by the villagers, in their boats shaped out of hollow trees, in February, and the same villagers ploughing the same land in March and April, when the surface water of last year had just dried off, and left the soil in a condition for the plough. A great deal of the Aumon is sown broadcast, and once it gets a fair start above ground, it will run a race against inundation, and beat it. Abul Fuzl, Akbar's celebrated minister, has declared, in the "Ayin Akbari," that this rice could sprout six inches in a night. I hardly like to endorse this dictum, but I think it very likely that it grows a couple of inches in that short space. Inundation of long continuance ruins it, but I have known it to be twelve hours under water, and then emerge without injury; and it is quite certain that if the water, whether rain alone or inundating river, will only rise gradually and not with a sudden rush, the rice plants will hold their own, and result in a magnificent crop. The length to which the stalks grow is surprising. I have pulled them fourteen feet in length, and am assured that they reach to eighteen. As the water recedes or falls this rice lies slanting on its surface; and a crop of Aumon rice in one big sheet, towards the end of November, presents the appearance of having been beaten down flat by some violent storm of wind and rain. A spectator, fresh from England, would imagine it ruined; a little experience teaches him that the crop, flat, tangled, white for the harvest, with a foot or two of water yet below it, and the blue sky, warm sun and pure air of December above, is in that condition described in the Virgilian hexa-

meter, "Votis demum respondet avari Agricolæ." But the whole of the Aumon crop is not sown broadcast. A large portion is called *roa* (from *ropan*, planting), and is planted out with the hand. A nursery is first selected near the cultivator's house, and sometimes in his kitchen garden, where the rice is sown as thickly as the ground can hold it, or the stalks can stand together; when this nursery has attained to at least the height of ten or twelve inches, it is taken out to be planted in rows in the ryot's field. To this end the field has been well ploughed, scraped, and cleaned. I have watched the same process in Ceylon. It is essential that it should hold from a foot to two or three inches of water, or at least of that mixture of mud and water which is popularly denominated slush. I have seen this work performed in water two feet deep, the ryot doing it from his boat; but usually the cultivator wades and sticks the plants in, with the utmost rapidity, in long even lines. In the first few days the transplanted rice wears a pale, sickly, weak appearance; but in a short time, with the water at its roots, and the sun striking its blade and incipient ear, the plants raise themselves upright, and become green and lively. At an agricultural lecture, I may be pardoned for again quoting from the greatest poet of agriculture. The great Roman poet would have said that they were amazed at their own strength and magnificence.

"Nullo tantum se Mysia cultu
Jactat, et ipsa suos mirantur Gargara messes."

So much, first, for the Aoos, with its simple and uniform culture; and next, for the Aumon, divided into the crop sown broadcast, and the crop planted out with the hand. There remains the Boru, and my remarks on this head will be brief, as this variety is only grown to a limited extent, on the edge of those huge swamps of which mention has been once or twice made. Where the swamps never dry up, and there is no other way of utilising the soil, the Boru rice is planted in January, or as late as March, just when all other harvest occupations are at an end, and being fed regularly with water, which can be dammed up or easily conducted by simple machinery, from one plot to another, the rice is ripe before May. The fiercest heat never injures rice, provided there is water to keep the roots wet.

I should explain further, that though the cultivation of rice is limited to three kinds, the varieties of the grain are much more numerous. Mr. Hunter, in one of his recent statistical works, states that there are some fifty kinds of rice. I can easily extend that list, and so could many other public servants. From a manuscript of my own, taken many years ago, I find that in one district alone, Jessore, there were thirty-eight varieties of the Aoos, sixty-two of the Aumon, and six of the Boru. A little practice enables us to distinguish the most prominent varieties as they grow. Some of them have elegant and expressive names. There is the pearl of the sun, the golden rice, the foam of the ocean, the Ganges and the ocean, the repast of the king, the supreme repast, the Balam well-known to Eastern epicures, and many others.

But it will be remembered that though the largest portion of the soil is occupied with the Aumon; that though no second crop is possible from land so cultivated, and that, when the crop is once harvested, the only use to which the soil is put is that of pasturage for the numerous herds of cattle, we have yet to account for the remainder of the year in regard to the Aoos. I have never seen regular pasture set apart for cattle, except in the scrub of Baucoorah and the West. I have allotted a period of about 110 or 120 days for its seed-time, growth, and harvest. What, then, does the ryot do with this land for the other eight or nine months in the year? When his rice crop has been cut and carried, say, in August and September, the last showers of the rainy season may be looked for any time in October. This rainfall is often the turning point of the year. In 1844, and again in 1848, and again in 1851 and in 1862, the population of Bengal was saved from scarcity, possibly from famine, by a timely fall of several inches, which occurred between the first week and the last week of October. Rain is then anxiously looked for, to give the Aumon crop its fullest development. It is also desired to fill the tanks, to prepare the land for what, in Upper India, would be called the Rubbi, or spring crop, and in Bengal, as I have said, the cold weather crop. The ryot sets to, ploughs up the land from which he has just cut and carried his Aoos, and sows it with the crop to which it is most suited. Amongst the favourite products are mustard, linseed, some oats, barley, the species of pulse which the natives call *sola* and Anglo-Indians gram, millet, *dhal*, and two or three smaller kinds of vetches. Once the seed is got in while the ground is still moist, there is little more to be done. For the next two months, which, in the Hindu calendar, are the

shishira, or dewy season, the dews are heavy and scarcely a drop of rain will fall; though sometimes in the cold weather, generally at the end of January, a fall of rain, not tropical but rather English in its character and duration—for it may last for a couple of days—has the happy effect of laying the dust, of prolonging the moribund cold season of Bengal, and of revivifying and ripening the cold weather crops. The Bengali have a saying that in the month of Magh—end of January and first half of February—they experience heat, rain, and cold—all the varieties of the year. The plains of Bengal, for ten months of the year, present features which redeem them from ugliness, and which are a pleasant contrast to the arid, brown, adust, or yellow look of Behar and Hindustan. There, the eye is offended as soon as the crops are off the ground. From June to October, nearly every plain in Bengal is one unbroken sheet of rich, green, rice cultivation; the small embankments, or divisions of heritages and fields, are hidden from the eye by the crops, and from the edge of one village shrouded in fruit trees and bamboos, to the other on the opposite side plain which forms the horizon, half-a-mile, one mile, or perhaps three, four, or even five miles off, nothing meets the eye but the even, unbroken sheet of rice. In the winter, one half of a plain may be white with the late rice crop; the other, higher and drier, is diversified with oats and barley, gram and vetch; and a sweet and delicious perfume from the golden flower of the mustard plant is wafted on the breeze to the traveller or sportsman. I hardly ever recollect seeing wheat grown in Lower Bengal.

It must not be imagined that this brief description of Bengali agriculture exhausts the list. I have said nothing about garden land or the higher kinds of produce. Jute, or hemp is a crop largely grown by substantial ryots or tenant proprietors. It is sown in spring, and cut in the rains; and then put to soak in tanks, exhaling a powerful and unpleasant odour; and there are two or more kinds of vetches which flourish in the same moist atmosphere, and anticipate the cold weather crop. In some parts of particular districts much attention is given to *pan* gardens. These plants, of which the leaf is chewed together with the areca nut, are grown in rows, just like our raspberries; but the peculiar feature of this cultivation is that the gardens are not only enclosed by mats at the side, but are roofed over by the same material, so as to concentrate heat, and yet exclude the direct action of the sun. Tobacco is also grown in small plots by the same substantial class; and a good deal of time and money is expended on sugar-cane. This crop, while it demands skill, perseverance, and expenditure for its development, returns large profits; and I have known instances in which an outlay of 20 rupees a beegah has been followed by a return of 40 rupees, or just cent. per cent. But the supply of coarse brown sugar or molasses, in Bengal, is mainly derived not from the cane but from the date tree, and the date plantations have, during the last fifty or sixty years, enormously increased over several well-known districts—Jessore, Burdwan, Baraset, and Nuddea. To explain all the operations by which the juice is collected and treacle boiled, would extend this paper to too great a length. It may be sufficient to say that the trees are planted in rows or clumps, and are not grown for fruit, as in Arabia or Biluchistan; that the tree becomes profitable after seven years' growth, and may continue to yield a return for thirty or forty. In the month of October the ryots are seen ascending their date trees, and making incisions on alternate sides, in alternate years, on the lowest branch of the feathery tuft at the top. An earthen pit is placed under each incision, and when the cold nights begin, the liquid flows slowly into the pot beneath, whence it is removed in the morning. The colder and stiller the weather the greater the flow of juice. Rainy weather, such as now and then interrupts the enjoyable climate of the cold season, stops the flow of juice for a time, but the process goes on, with few intervals, between November and March. The juice is boiled down and clarified by means of a coarse weed that grows in almost every tank, and the whole cultivation is highly remunerative. The spaces between the trees in a date plantation are turned to account otherwise, for early rice and for the second crop of mustard. Many substantial ryots own 400 and 500 and even 1,000 of these trees, and the traffic in *goor* or treacle, adds life and animation to the interior of Bengal. Towards February, the sight of fifty or a hundred country carts, groaniug and creaking over the fair-weather roads under quantities of molasses on their way to such celebrated marts as Kissubpur or Kotchandpore, in Jessore, is one which—to borrow an expression of Sydney Smith when he imitated humorously the grave style of Macintosh—explains the objects of commerce, approximates the different regions

of the earth, and justifies the industry of man.

But ryots who have neither the industry nor the capital to construct *pan* gardens, or to plant the date or the sugar-cane, yet generally contrive to have something of a garden. A village in Bengal is usually hidden from the eye by its dense mass of foliage. It was a characteristic and just observation of an eminent North-west civilian (now Member for the Kirkaldy Burghs), when he first came down to Bengal, that there were few or no large towns to be seen. There are, on the banks of rivers, some very large *gunges*, or wholesale marts, or centres of trade; but a rural village which contains 300 houses often appears to the eye as a mere jungle, the wild cane and brushwood, the feathery grass, the plantain, and scrub of all kinds growing with clumps of bamboos, while waving above them are seen the cocoa palm, the date, the toddy palm, the graceful stems of the areca-nut, and, here and there, the pipal and the banyan, those grand trees which Macaulay said were perhaps older than the Mogul empire itself. No one can have resided a week in the interior or visited a few villages, without being struck with their perplexing similarity, with the recurrence of the same landmarks, with the same features of narrow winding paths, of tanks of every degree of size, cleanliness, or pollution, of gardens surrounded by deep ditches and slender fences, of slutish, careless, rotting abundance, of spaces where weeds and undergrowth seem to struggle for mastery with the egg plant, the red-pepper, the tobacco, and dhal and pulse. It has been truly remarked that a traveller taken half an hour's journey or ten miles out of Calcutta, and suddenly put down in the centre of an umbrageous village, would be puzzled to discern the slightest difference between it and a hundred similar villages, situated north or east, three or four days' journey off. It seems impossible to get villagers to understand that air, light, and ventilation are essential to health, that fruit trees can be planted too thickly, and that everything ought not be sacrificed to the mere object of excluding the rays of the sun, and shielding the woman-kind from the intrusive glance of strangers.

I turn now to the actual processes and the very implements of Bengali culture. Fortunately, I have by me exact models of the implements in use by thousands of cultivators, made twenty-five years ago by a village carpenter, and I have no reason to think that, even in this age of progress, their form or substance have in the least altered from what they were then, and possibly also were in the days of Manu. The plough is in shape very like an anchor. It is generally made of the wood of the mango or the baubul, and it is a common occurrence for the ryot to find the wood and even the iron for the shares, then go to the village carpenter, who will put the two together for four annas, or 6d. I mean that this is more common than buying a plough ready made. It must never be supposed that furrows are turned by this implement to the depth and regularity seen on any English farm. The ryot begins by a series of intemperate and intermittent scratches; ploughs down the field and across the field, and down the field again, but in the end often produces a complete pulverisation of the glebe. It was remarked to me by a friend, at the time when a late Lieutenant-Governor 20 years ago was holding agricultural shows all over Bengal, and trying practical experiments with steam ploughs and deep furrows, that no ryot would ever be satisfied with any conceivable plough except one which he could put over his shoulder and carry home after the day's work. I think the outline of the native plough might be amended, for I have actually guided the plough myself, and found that it is difficult to get the share to bite, but even on this I hesitate to have a decided opinion, being convinced that, in many points, the ryot has more to teach us than we have to teach him. Then comes the sowing broadcast, and afterwards what we should call the process of harrowing. The Bengali harrow is, however, as unlike our harrow as any one instrument can be. It is a simple ladder of bamboo, on which one man takes his stand, while his fellow draws the bullocks to which the ladder is attached, by two cords, over the sown field. At a distance the ladder is imperceptible, and the ryot seems to be moving over the surface without using his legs, as if by some magic power. The effect of this process, when carefully carried out, is to make the rice ground almost as level as a bowling green. The Bengalis have a third process, in which an instrument with teeth, a large sort of rake called the *bida* in some districts, is brought into play. It is used when the rice is about six inches high, and is drawn over the open spaces, avoiding the roots of the rice, to prevent the surface caking too much, and to admit of the exhalation of moisture and the sun's rays. The next operation is that of weeding, and this is often well done, is often half done, and

is sometimes not done at all. The best agricultural classes weed the Aumon crop sedulously in August and September. They use, for this, a small hand-spud, and squat on the ground, covering their heads with an umbrella without a handle, made of leaves and split bamboo, in which position they resemble gigantic toadstools. It is a pleasing feature of this operation that each man takes it in turn to help his neighbour. In village language this is termed the *ganth*, or knot. It is the *ganth* of Ram Gopal one day, and Tin Kaori, Panch Kaori, Nou Kaori Mandal, and all the rest, turn out to weed Ram Gopal's plot at his call, being sure of a like co-operation the next day, each man in his call or turn. The whole stock-in-trade of an ordinary agricultural ryot will then consist of a pair of bullocks, or, it may be, two pair; a plough, which may cost one-and-a-half or two rupees, and may last for twelve months or two or three years; the bamboo ladder, which costs much less; the *bida*, or scuffler; the weeding spud; a fish-basket, to be set in the rush of water from one field to another to catch the fish which leave the tanks, and frequent the rice fields in the rains; a *kodali*, or mattock, for breaking up new land, excavating ditches, and repairing embankments; and a *dao*, or bill-hook, for cutting wood, splitting cocoa-nuts, and shaping bamboos. I am sorry to say that this latter weapon is a sore temptation, and plays a prominent part in domestic or social quarrels; and many a wife, or cousin, or nephew, or neighbour, has had his head cut open and his limbs slashed, by an impatient husband or jealous relative, when heat exasperates the temper, when words run high, and provoke retaliation by deed.

Of cultivation by hired servants, there is not much. Substantial men, respectable Brahmins, owners of rent-free lands, and small talukdars occasionally get their crops sown and reaped in this way. But the best agriculture is to be seen on the lands of the Hindu agricultural castes, the Kopali, the Teor, the Sudgope, the Kaivert, who correspond practically to the Jats and Kurmis of Upper India. There is, however, a third mode of cultivation, besides ploughing your own land with your own bullocks, or sending your own hired servants to do the work. It is known in Bengal as the Barga system. One man may have land but neither plough or bullock; another man may have bullocks, but not too much land, and can devote spare time to the lands of others, when he has sown his own. So the two agree in this fashion. The ryot who has a pair of oxen, brings them to the plot of another, and expends on it his labour and time. Sometimes seed is advanced by the tenant proprietor who has no bullocks; but when all the agricultural operations have been gone through, the simple contract is determined by the division of the crop, grain and straw, as sown and reaped. The man who does the work is, of course, under no liability for the rent of the land. Threshing, I should mention, is generally done out on the plain, and not near the ryot's house. A spot on the edge of the field is smoothed, cleared of weeds or stalks, and hardened till it becomes like a pavement, and the threshing is accomplished by the simple process of allowing the bullocks to tread out the seed. The Scriptural precept of not muzzling the animal is invariably observed. The rice, when threshed, is carted or carried away to the ryot's house, and sometimes half-boiled, and stored in pits, or oftener stacked on round frames, called *golas*, till it is wanted for consumption or sale. The process of separating the husk from the rice, and making the latter fit for cooking, is carried on by an instrument, called a *dhenki*, or wooden pestle and mortar. This duty is usually performed by women. My description of agriculture takes no account of the years when the failure of the usual rainfall inflicts misery on thousands, and chills the hearts of administrators and financiers. To enter on the subject of famines would require larger space and time than be afforded; and the Report of the Famine Commission, I believe, deals effectively with this subject. I keep strictly, therefore, within the limits originally proposed. A few words on the general effect and out-turn may not be amiss. Nothing is more striking to a patient observer than the variety, not of the processes, but of the results. I was once in a position to observe narrowly and constantly the difference between tilth in the hands of capable and incapable workmen. Within a couple of miles of each other were two villages, enjoying the same advantages of soil, rainfall, and climate. One belonged to the agricultural caste of Hindus known as Sadgope. Men of this class have no handicraft, desire no appointment as peon, watchman, or policeman, do not even care to drive a cart, but devote themselves exclusively to agriculture. The result was that bullocks and milch kine abounded: large families occupied each homestead; every plot of ground was thoroughly ploughed, harrowed, and weeded; the returns were solid;

and each family or household was, if not rich, certainly independent, and far removed from indigence or suffering. The other, a much larger village, was occupied by the class of Mohammedans known as Jolha Karigars, or weavers. In the lands of this village were comprised early and late rice, orchards of mango trees or plantains, and date trees. Several of the ryots had small local employments, which brought them regularly in a few rupees a month. Several carried on the trade of weaving, and turned out light suits of clothes, which, I am sorry to say, twenty-five years ago were being gradually improved off by the market by Manchester or American piece goods. There could be no doubt that more money circulated in the Mohammedan than in the Hindu village, but the difference in agriculture was apparent to the casual glance. The ploughing was superficial, the harrowing careless, and the weeding was neglected. I lay stress on this point, because I have seen it stated that the returns from Indian agriculture might be indefinitely increased by what is termed the outlay of capital, scientific processes, the use of manures, and other grand and ambitious schemes. As regards manure, I am glad to observe that Mr. Hunter, in his recent statistical volumes, puts this matter on its proper footing. Most ryots know the value of manure for high lands, and it is constantly applied to date and sugar cultivation, and to gardens. For the deep and late rice no manure is needed. The best restorative to the land in such cases, I hold to be continuous tropical rain, or the silt brought down by the Ganges and its affluents or distributaries. In any case, the absence of manure is due to poverty and not to ignorance, and it would require an exhaustive description of the rights, privileges, and duties of superior ownership to explain why large Zemindars do not direct cultivation, and cannot be expected to expend capital on manure. Cowdung, which abounds, and has certain fertilising properties, is too valuable as an article of fuel to be stored up for manure. It has always appeared to me, from close attention given to this subject, that (as I have already remarked) those who talk glibly about instructing the Bengal ryot will have to admit, when they have watched him at work, that they may derive a good many lessons from his operations. No doubt there are many instances which appeal to the eye of imperfect tilth and second-rate crops. But the average ryot is thoroughly well acquainted with the set and lay of his fields, his neighbour's, and their watersheds. He knows when to sow, and plant out, and weed. He rarely puts the Aoos where the Aumon should be planted, though I have noted one or two instances of perverseness or obstinacy in this respect. He knows how to dam up water, and store it or let it off as required; he is quite aware of the fact that tobacco, sugar-cane, red pepper, or the pulse called dhal, require constant and close supervision. He will frequently sell the very stubble off his field for fuel to the sugar manufacturer, after the regular straw has been carted away; he knows how to build, repair, and thatch his house; how to store his straw; and the neatness and cleanliness of his actual residence, including courtyard, verandah, and cooking house, is in striking contrast to the accumulation of dirt and decaying vegetation outside his residence, which taints the air, defiles the water, and engenders divers forms of deadly disease.

No doubt the labour of a Bengal ryot is not equal to that of the thews and sinews of a Northumbrian or Yorkshireman. A strong Hindu agriculturist may plough one beegah of land in a day; and the Bengal beegah, in contradistinction to that of Tirhoot, is about one-third of our English acre. He would drive the harrow or ladder over eight or ten beegahs. To weed only a quarter of a beegah would be an extremely good day's work; and to plant out a beegah of land with rice plants would require the undivided labour of three men a day. I have timed men at this operation, and noted that one good worker put in sixty-five to seventy-five plants to the minute. His rapidity and dexterity were perfectly surprising. A less vigorous worker only put in fifty to the minute, and three Mohammedans admitted to me that this part of the work broke their backs. A few other minute statistics may here not be out of place. They were collected when I had no thought of presenting them to an English audience.

A stalk of late rice, 4 ft. long, taken out of a fair average crop on the 1st November, about three weeks before the harvest, contained 174 grains; another, in the same plot, 3 ft. 10 in., had 134 grains. On the 7th November, 206 grains were counted on a single one of six or eight stems growing from one and the same root; another stem had 133. Later, in the same year, on November 30th, a rice stalk from a thick clump, about which in ordinary years there would have been a foot of water, gave 233 grains. On the 30th December following,

three stalks of rice, in the same plot, gave respectively, 200, 145, and 168. Here again is an account of the return of rather more than one beegah of early or Aoos rice. Two varieties were sown (Mahesh Dhali and Baro Jamriya), the former gave fifty-five baskets of ten seers each; the latter, thirty-six baskets. The best ears of the Mahesh Dhali gave 290 and 270 grains each. The Baro Jamriya gave less, but of a finer kind, being 117 and 113. This was cut the first week in September, and it was roughly calculated by my informants, the owners, that about two maunds had been shaken out by the wind and lost.

Here is the produce of a piece of sugar-cane on four cottas of garden land; or, length, 35 ft.; breadth, 25 ft. There were nine rows:—

1st row	51
2nd ,, ...	77
3rd ,, ...	72
4th ,, ...	73
5th ,, ...	91
6th ,, ...	87
7th ,, ...	89
8th ,, ...	83
9th ,, ...	74
	697

The proceeds, at one pice a cane, was nearly eleven rupees. The height of the tallest cane was 15 feet 8 inches. The expenses of the slips for planting was seven annas; labour, three rupees; propping the canes by bamboos and ropes, about eight annas—in all, some four rupees; so that the clear profit was nearly seven rupees.

A few words towards the conclusion of this paper may not be out of place, in connection with the possibilities of improving agriculture, and getting more out of the land, an object of importance, both with regard to the contingency of famine and the enormous increase of the rural population. This matter assumes a gigantic proportion when we remember that, in some districts, the population averages 500 or 600 to the square mile. I will reiterate that glowing estimates as to power of the soil of Lower Bengal, if skilfully cultivated, to give a return of 50 and even 75 per cent. over its present outcome, appear to me to rest on neither probability nor proof. In the first place, on a large portion of the deep land of Bengal, the cultivation has been stereotyped by Nature herself. It will bear the late crop of rice, and it will bear nothing else. It is idle to talk of manuring, or ploughing deeply, land that needs nothing but plentiful, continuous, and seasonable rains to produce rice of the largest stalk and the heaviest ear. With a good season, there is nothing to prevent this sort of land bearing a fine harvest year after year.

It may happen that an excessive rainfall every now and then ruins these deep lands, but loss from inundation in India is partial and even trivial compared to that inflicted by drought. I except, of course, such visitations as the tidal wave of the Megna. Some miles of country may be submerged by the overflow of a river, and the harvest spoiled, but such damage is local and temporary, and is partly compensated by the filling of tanks, the flushing of ditches, and the deposit of rich silt left by inundation. But as a physical fact, the land of the Delta is rising, and has been rising for years. Bheels and swamps are gradually silting up by the action of rain-water, or water charged with deposit, and every now and then a distributary of the Ganges pours a fertilising flood over a large span of country on each of its banks. Within the memory of man, many a Bheel or swamp, the haunt of waterfowl and fish, of coot and heron, has so risen as to be fitted for the plough; and while swamps have been converted into rice-fields, rice-fields in their turn have become villages and gardens. Something has been done by the Government of India by the creation of a Special Department of Agriculture, to record statistics and to establish model farms; but this Department has, if I mistake not, been recently abolished or doubled up with another, and I doubt very much whether there exists in Bengal any machinery for ascertaining accurately the gross or the net return of any one given area. Statistics of population, of cultivable, cultivated, and waste lands have, no doubt, been ascertained by the survey. The Pergunnah rates of rent are also well known. But though it is quite possible to judge of the difference between careful and slovenly tilth, between the best of Hindu and the worst of Mohammedan cultivators, I reiterate that it would be rash to predict from the most careful husbandry an increase of more than 10 or 15 per cent. in the produce. It is impossible to show, in the limits of this paper, how large Zemindars cannot be expected to vary or improve the general cultivation of the tenantry. Bengal Zemindars exercise no influence over the course of cultivation. They may cut a canal, dig a tank, lay out a road, or establish a weekly market. But the whole custom of the country, whether based on traditional precedent or confirmed by judicious legislation, is

against their spending capital, as an English landlord does, in scientific agriculture and high cultivation. The introduction of the higher and more lucrative products has been entirely the work of substantial Gantidars, jotedars, or tenant proprietors, call them by any revenue or local term that you choose. These men may own a village, or half a village, or fifty beegahs. Something, of course, may be done to manure the land by those who can afford it; to cultivate garden produce, with some attention to the pruning and grafting of fruit trees; to introduce fresh seed from other Provinces; to improve the breed of cattle, and, possibly, on the high lands, to give the soil rest by rotation of cold weather crops. But, in a very large area, rotation is a simple impossibility, from the very nature of the crop. A good deal has been done by the Government to assist the agriculturist, by opening up new communications, and improving those in existence. Railways have connected distant provinces, and have been supplemented by metalled and by fair-weather roads; law and order have become paramount; the great waterways have been made secure against dacoits, and crimes of violence have been put down; and all these reforms tend to the security of the producer, and enable the surplus of one division to supply the deficiency of another. To all this no one, in his day, has contributed more than the eminent public servant who fills the chair to-night. You will remember, also, that manufactures in Bengal are only just in their infancy; and that hitherto—except by emigration to Assam and a few other places—there have been found no ready means of easing any part of Lower Bengal of its surplus population. But I do not attempt, at the close of this paper, to do more than show the inherent serious difficulties of the agricultural problem, and to warn you against putting faith in the jaunty predictions of confident prophets, who maintain the feasibility of indefinitely increasing the out-turn of the harvest, and in making, everywhere, two or three blades of rice grow instead of one.

I now think it not out of place to state that very little, if anything, is taken at second hand, or from books and reports. It is, be its value what it may, the fruit of past, direct, constant, personal inquiry into the means and status of the ryot, and of notes and statistics gathered unofficially in walks and rides round the plains and homesteads, the garden and the tank, and immediately committed to manuscript or to print. In this I lay claim to no special merit, and only pretend to have followed the example, as far as was possible under a different system of revenue and official agency, of those eminent administrators who, in the North-West, Oudh, and the Punjab, have laid the foundation of order and contentment on an intimate knowledge of the habits and requirements of the masses. And I may express a hope that the present generation of able and rising civilians in Bengal may neither be so drenched with statistics, nor overwhelmed with calls for returns, nor so cabined and confined to the desk, as to be unable to mix freely with the agricultural population, and so obtain that familiarity with village life which examination papers or Blue-books can never equally afford. As I write, the old familiar scenes seem to rise before me; the vast plains with unbroken sheets of rice, and the dense artificial jungle of the village; the reservoirs of deep water and high banks which the munificence and piety of one generation had called into existence, and the negligence of a succeeding one had allowed to fall into decay; the network of rivers, teeming with fish and covered with craft of every description, from the lightest canoe to vessels of the most unwieldy bulk and ample stowage; the myriad population with their carts and ploughs engaged in taxing the soil for existence, or carrying their produce to the nearest mart; the spire of the missionary's church unexpectedly rising out of the exuberant foliage of some hamlet, the lonely bungalow of the civil engineer or the planter; and the white kutcherry, where a young man, not thirty, with an alpaca coat and a felt hat, is the representative of British authority, and the guarantee not only that the harvests shall be gathered unmolested by Mahratta raid or Mohammedan invasion, but also that, however protracted or fierce may be the passing controversy as to tenant rights, executive changes, and legislative progress, yet whenever a wise and judicious course of action has been determined on, the State shall be served with that heartfelt loyalty and that disinterested obedience which neither shows any trace of party conflict, nor admits any invidious distinction of race or creed.

DISCUSSION.

Rev. T. LONG said that the reader of the paper, as one of the grand old school of civilians, was a model for those who came after him, as the knowledge which he had acquired was not obtained

merely from books, but was the result of personal observation during a long residence among the people.

Mr. CHARLES CAMPBELL thought that there was no one who knew Bengal better than did Mr. Seton-Karr, who, by his paper, had enabled many of them to revisit as it were the scenes of their youth. He (Mr. Campbell) had spent the best part of his life in and about the region a description of which had been given them, and he could testify to the extreme accuracy of the general description. Referring to the cultivation of jute, the speaker said that when first he went to India there was scarcely any jute grown, and now it had become one of the greatest products. It was the same with the date; and it seemed to him that if a Bengal ryot were shown that he could sow any particular crop to his advantage, he set about it immediately. The zemindars, however, charged a very much higher rent for the privilege of growing the date than they did for growing rice. He was sorry that some allusion had not been made by the reader of the paper to the way in which rice was prepared for keeping, as, of course, he was well acquainted with the whole subject, and an account of this process would have been extremely interesting. As to the three kinds of crops to which Mr. Seton-Karr had referred, the speaker said that generally there was only one crop, namely, the Aumon, compared with which the other crops were comparatively insignificant. To hear some people talk, one would imagine that Bengal produced three or four crops a year, but that was quite a mistake.

Mr. KRISHNALAL DUTT said it was highly gratifying to him, who had crossed the ocean from India, to find eminent and educated men in this country who were eager and earnest for the improvement of his native land. Bengal depended greatly on the produce of agriculture, and the work of the labouring classes. These classes were very poor indeed, because they were so numerous; and this poverty had been deplorably added to by the treatment to which the indigo planters had subjected them in past years, and from which treatment they had not yet recovered. Bengal, under favourable circumstances, could scatter its harvest not only over India, but over every part of the world. They had seen many agricultural improvements, but more were wanted. In many districts in Bengal the floods destroyed the crops, and drove hundreds of families to want and starvation; and if it was desired to encourage agriculture, it was necessary that the Government of Bengal should be induced to construct dams and bridges for the prevention of these floods. Then again, more fields should be brought under cultivation, and improved means of transport should be provided. He considered that one of the principal wants in agriculture in Bengal was cattle, which were rapidly becoming more scarce. Five years ago, the price of a pair of bullocks was 30s., now it was £6; and as £6 often represented a whole year's income of a ryot in Lower Bengal, it was evident he could not afford to buy cattle. Thousands of men were unemployed in consequence of this scarcity of cattle, and he attributed the cause to the consumption of beef by Englishmen resident in India. He was certain that agriculture in India would never be improved until a proper substitute for cattle could be found, and he questioned whether it was possible to find such a substitute.

Mr. R. N. CUST said that he visited the reader of the paper many years ago at Jessore, while he was engaged in the work, the result of which was the paper they had heard. He saw that Mr. Seton-Karr was a public officer who had deep sympathy with the people who were under him, and that was the real secret in the management of those people. He also found that he could talk with them in their native tongue, and that also was a most important point, which he (Mr. Cust) hoped would not be lost sight of in the future government of India. There were many people who, no doubt, had known quite as much about the subject of the paper as Mr. Seton-Karr did, but unfortunately their knowledge had perished with them, while he, in addition to possessing the gift of observation, also possessed the gift of recording the result of his observations in a way which could be read and appreciated by others. The speaker stated that he had, from personal experience, come to the conclusion that the ryots knew what was best, and much more than we could teach them with regard to agriculture. They had had long experience from father to son in the management of their land, and had had good crops for thousands of years (with short intervals of famine) from these marvellous plains of India. In the Punjab, there was a strong resemblance to the Bengal mode of procedure in agriculture, with the one essential difference, that in Bengal there seemed to be too much water, while in the Punjab there was too little. In the former province, the people lived by tanks and the overflowing of water and rivers, and, in the latter, by irrigation, water-pumping, and really the well there was the basis on which the cultivation rested. There was not so much rice produced as formerly, but wheat, the sugar-cane, cotton, &c., were grown, producing the great wealth which enabled the country to pay such an enormous annua revenue. With respect to the tenures of the ryots, the speaker hoped they would not be interfered with. The rich zemindar was not allowed to oppress the ryot, and squeeze out of him every farthing he possibly could. There were three rights co-existing in the land, and he wished people to understand, with reference to Ireland, that those rights could exist together. There was the right of the revenue, the right of the landlord to his rent, and then there came the tenant with his right. On that basis India had flourished,

and he trusted that the same system would continue to be followed with regard to tenant right in that country. In conclusion, the speaker expressed an opinion that any young civilian entering on life in India, could not do better than to study the paper for his guidance, as he was perfectly sure he could not get the information from any other existing work.

Mr. ANDREW CASSELS, much as he had admired the general tone and scope of the paper which he was sure all who were present must have been deeply interested by, could not agree with all the statements that had been made by Mr. Seton-Karr, who had said that the ryots of India could teach us more than we could teach them. He thought he might leave the concluding part of the paper itself to answer that remark, for it had finished by showing how agriculture in Bengal could be improved to the extent of from 15 to 20 per cent. He (the speaker) thought that there was great room for improvement in agriculture in Bengal, and in all India, and in thinking so, he believed he was in very good company. He remembered a minute addressed by Lord Mayo's Government, in 1870, to this country, in which it was stated that scientific agriculture in India might be said to have no existence. At that time Manchester was saying a good deal of evil of the Government of India, but he ventured to assert that Manchester never said so much evil as the Government of India said of itself in that despatch. He had known of several able men who had pointed out how very much might still be done towards the improvement of agriculture in India. Sir Richard Temple, in that room, three years ago, when Mr. W. R. Robertson read a paper on agriculture in Madras, gave his opinion most plainly and emphatically that, under the existing system of agriculture on the part of the natives of India, the soil was gradually deteriorating, and that nothing was more necessary than reform in agriculture in that country. With the opinions of such an authority before him, he ventured to assert that they could do no better work than to strive to improve agriculture in India; and that it was capable of great improvement there could be no doubt. In proof of the advantage which had been derived from the teaching of Englishmen during the last twenty-five or thirty years, the speaker called attention to the large quantity of tea which was now produced in Assam; of jute in Bengal; and cotton in Western India. Many years ago a cotton field yielded, at the utmost, thirty pounds of clean cotton. Now in some places the yield was sixty pounds, and in the majority of cases it was fifty pounds. Englishmen had also been instrumental in introducing the cinchona tree, and he was fully persuaded that this country was by no means at the end of its tether, as regarded the teaching of agriculture to natives of India.

Sir W. ROSE ROBINSON, K.C.S.I., observed that, as far as Madras was concerned, they had realised that education in agriculture was the one thing that was necessary; though, perhaps, he ought not to particularise Madras, as the subject of the paper was exclusively in relation to Bengal. Alluding to the models of the various agricultural implements which had been exhibited, the speaker said that he never saw models of such instruments exhibited without regret. They reminded him of the exceedingly backward state of agriculture. He did not mean to speak disparagingly of the people's work, but they all knew that the implement which Mr. Seton-Karr had called a plough was only a thing for mixing up the mud in rice swamps, and really an effective instrument for that purpose. It was not suited to plough up the earth, and did not do so. In Southern India, however, the agriculturists were beginning to understand that there was such a thing as a good plough; and a manufactory that was attached to the Madras farms at the present time was turning out hundreds of ploughs. He rejected the remarks of Mr. Seton-Karr that English agriculturists have aught to learn from the Indians, and that little can be done in the way of improvement in agriculture in India. The result of the English system on the Madras farms show that it were easy to double the produce of dry land. By a recent report, he found that 100 ploughs had been sent out to Madras for use on the farms. He was sorry to see that the Government Agricultural Department in India had disappeared, because he was sure that that department had had a very good effect upon the country.

General RUNDALL, C.S.I., R.E., said that having spent many years of his life as an irrigation officer, he had been thrown into close connection with the agriculturists of India, and was therefore able to corroborate to a great extent what Mr. Seton-Karr had said regarding their conservative simplicity. Whether that simplicity was conducive to their welfare or not, he considered problematical. With reference to the employment of manure, which Mr. Seton-Karr said was not necessary for rice cultivation as long as there was a continuous downpour of rain, he (Gen. Rundall) stated that there was little or no manure in rain water, and that it was not a fertiliser, but merely a maintainer of the growth of the rice crops. He had seen rice growing in nearly all parts of India, and had found that where a river, the water of which was laden with silt, could be brought to flow over the land, the finest manure was obtained; and it was a notorious fact that in Bengal, wherever the natives could get silty river water, they would drain the rain-water off their land, and flood it afterwards with the river. The speaker referred to the Hooghly drainage scheme, which was first started when he was chief engineer in Bengal, and which had enabled the ryots to cultivate a large tract of land which formerly was a pestilential swamp, and to cultivate it so successfully that now they obtained rich crops; and the zemindars and others, who were

responsible for the money which was raised to carry out the project, were not only able to pay off the interest on the debt, but to form a sinking fund to discharge the capital. Mr. Seton-Karr had alluded to the extraordinary prudence of the ryot in selling the stubble off his field, but it seemed to him (the speaker) that it would have been much wiser of the ryot if he kept that stubble, burnt it, and put the ashes into his own ground afterwards, because in those ashes there would be the manure which was well suited for a rice crop. Referring to the question of cattle, he thought there was decidedly room for improvement in that respect, and considered it was impossible, without good cattle, for cultivation to be carried out to a proper extent. He could not quite agree with Mr. Krishnalal Dutt, who had attributed the increasing scarcity of good cattle to the English consumption of beef, as that consumption must be comparatively small; but the question of improving the breed was one which should engage the attention, not only of the Agricultural Department, but of the local officers. With regard to means of communication, water he considered to be the national mode of carriage, if not for all India, at all events for Bengal. He had heard from Calcutta, lately, that a company was being started for the purpose of navigating the canals in Bengal, and he believed the Chairman of that meeting was one of the first persons to give the question of steam navigation on those canals an impetus. He was sure that they would all echo the concluding remarks of Mr. Seton-Karr with reference to the necessity of personal communication between the governors and the governed, the vast importance of which, he was sorry to say, was in these days very often lost sight of.

Mr. Martin Wood regretted that one or two gentlemen present, whom he knew to be authorities on agriculture in Western India, had not offered some remarks, which would have afforded useful points of comparison with the methods and condition of the Bengal ryot so well described in the paper just read. And they must still more regret the entire absence of any statistical information in the paper as to to the total results of all that careful cultivation which Mr. Seton-Karr had so justly commended. And it did seem to him (Mr Wood) a great blank that nothing had been said as to what became of the rent of the vast surplus that must arise from these labours of the Bengal ryot. But the discussion had been full of interest. Though they had heard from the various speakers of the very different systems of agriculture and land tenure in different provinces of India, he was glad to recognise that they were all united in one respect, namely, in protecting the right of the cultivator in the soil that he tilled, a principle which, he believed, was universal throughout India, with more or less qualifiation. On recurring to the title of the paper, he must confess to some little disappointment, for he had expected to hear Mr. Seton-Karr tell them something about tenant-right in Bengal, because he was eminently qualified to speak on that topic. But he had only mentioned the subject just to pass away from it. Probably he had good reasons for not dwelling on that large subject at present.

The Chairman said he had listened with great interest to the paper which had been read, and he thought the conclusions to be drawn from the discussion were, that the ryots of India, especially those in the provinces with which Mr. Seton-Karr had dealt, were the most patient, industrious, and persevering cultivators in the world, and were not by any means so ignorant as they were represented to be. He quite agreed with the view which Mr. Seton-Karr had taken, which he understood to be that what the ryots of Bengal wanted was, not scientific teaching in agriculture, but security of life and property, security of tenure, a settled demand for their produce, easy communication to markets at which they might sell that produce, irrigation in dry parts of the country, and some re-distribution of the population. As to the question of agricultural improvement, he thought Mr. Seton-Karr had not quite succeeded in avoiding a controversial subject, but he thought he had been to some extent misunderstood. As he understood his views, he did not attempt to say that the Bengal ryot was a perfect cultivator, any more than the agricultural classes in England could be said to be so. They all had something to learn. What he did say, however, was that they were people who were very accomplished and capable cultivators, in view of the work that they had to do, and the means at their disposal; and they all knew, as a matter of fact, that they had succeeded in raising enormous crops, far in excess of their own requirements, and were able to export a very large surplus produce. In Burmah alone, for instance, they exported no less than 800,000 tons of rice annually, and there the people were quite the idlest cultivators in India, and the population and area of cultivation were small; but, in the face of such a fact, it could not be said that they were a people who knew nothing of agriculture. As to what had been said of the success of agricultural teaching at Madras, he had carefully read all the reports up to the latest date, and he failed to find that the superintendent of the Government farm at Madras had taught the people of Madras anything; in all his reports, the only thing which he could find was, that he had introduced some ploughs, and he (the Chairman) believed that those ploughs were an adaptation of the native plough.

Sir William Robinson—They were Swedish ploughs.

The Chairman could not see the utility of teaching people who had fields no bigger than that room the use of steam ploughs, nor of winnowing machines for crops that could not be winnowed by machinery. They must remember that in the Gangetic

Delta, of which Mr. Seton-Karr was speaking, the culturable part of the soil was only a few inches thick on the top of sand, a mere veneer, and the ryot knew perfectly well that if, by deep ploughing, he brought that sand to the top, he utterly destroyed his chances of raising a crop. The poor ignorant ryot had found this out by experience, and other wiser people would find it out in time. In the same way he had found out that he did not require implements intended to deal with stony soils, when the soil he had to cultivate was a soft garden soil without even a a pebble in it. With regard to what had been said as to cattle in Bengal, it was not that experiments had not been tried, but it had been found that large cattle, which would live in other parts of India, would not live in Bengal. The exposure to the heavy rains, combined with the fact that the wet grass was not sufficient to support them, caused them to pine away and die. There was only one thing to which they need look in proof of the capability of the cultivation, and that was the actual result. Had the Indian cultivator ever been asked by England to produce anything which he could not produce. It was not a fact that the production of jute had been the result of any teaching of Englishmen, it was the spontaneous response of the people to a real demand. When the Crimean War broke out, and the ryot found out that there was a demand for this article, and that merchants would pay a fair price for it, in one year the markets were filled. Then, as to tea, to which allusion had been made as a product, the result of agricultural teaching, he had never heard of any agriculturists being taught to grow tea. He always thought the production of tea was entirely in the hands of European planters; and he certainly had never heard of the ryots having been taught to grow tea or cinchona. As to cotton, he had no doubt that a great deal of good had been done in the way of teaching them to select their seeds; but taking the actual results, it could not be proved that the English had yet done anything by way of teaching the ryot to grow crops better than he grew them before. In conclusion, the Chairman proposed a vote of thanks to the reader of the paper, which was unanimously carried, and in responding,

Mr. Seton-Karr said that his subject had dealt entirely with Bengal, but he was, nevertheless, much obliged for the criticisms which had been made, and by which he had profited.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 14th, 1883; Mitchell Henry, M.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Anderson, James, 19, Strand, Calcutta.
Bartlett, Herbert H., Tredegar Works, Bow, E.
Bostock, Henry, The Oaklands, Rowley-avenue, Stafford.
Dawson, Philip William, 96, King Henry's-road, N.W.
Hammond, Frederic, 2, Mercers-road, Holloway-road, N., and 2, Coleman-street-buildings, E.C.
Lever, Charles, Culcheth-hall, Bowdon, Cheshire.
Marshall, George Stansfeld, 41, Elsham-road, Kensington, W.
Mason, James, J.P., Eynsham-hall, Witney, Oxon.
Silverlock, Henry Thomas, 32, Elgin-crescent, Kensington-park, W., and 92, Blackfriars-road, S.E.
Stuart, John Medley, 20, Addison-road North, Kensington, W.

The following candidates were balloted for and duly elected members of the Society:—

Baldwin, Alfred, Wilden Ironworks, near Stourport.
Farnworth, William, Swindon, near Dudley.
Fleming, George, Cathcart-lodge, Tyrwhitt-road, St. John's, S.E.
Hallett, William Brown, 326, Holloway-road, N.
Hammond, Robert, 110, Cannon-street, E.C.
Sonnenschein, Franklin John, Helmsley, Wimbledon-common.
Wisdom, F. W., Rosedale, St. James's, Hatcham, S.E., and 20, John-street, Adelphi, W.C.
Yule, Sir George Udney, C.B., K.C.S.I., 30, Clanricarde-gardens, W.

The paper read was—

THE DEVELOPMENT OF IRISH INDUSTRIES.

By John Caldwell Bloomfield.

At the outset of this paper, I wish most distinctly to disclaim any political intention. My object is simply to bring before the Society of Arts, and before the public, a proposal which I believe would have the happiest results on the future of the Irish people, by removing the poverty and consequent distress of the people, and by providing employment for the many hands which are now idle merely because there is no work for them to do. That proposal, briefly stated, is to establish, throughout the country, centres of organisation for the many important though minor industries which, I hope to show you, the country can, in various localities, successfully support. Many of these industries can be well carried on in the homes of the people themselves, and it is for that reason that I call them "Home Industries."

To show you that I do not speak on this subject without, at all events, a certain amount of authority, I may be permitted to refer to the successful, and now, I am glad to say, well-known establishment at Belleek for the manu-

facture of pottery; since it is the experience gained since I founded that establishment which makes me feel certain that similar efforts in other parts of the country would be attended by similar results.

Those who have been enabled—without political or religious excitement—calmly to survey and consider what is termed the "Irish Question," see in it merely the natural results of a state of things abnormal in really civilised States, viz., somewhere about 500,000 families dwelling in erections unfit to shelter an average beast, with farms commonly attached, that, either from poor quality, absence of recuperative means, want of markets for produce, or all combined, leave the occupiers so near the boundary of starvation as to render them—impulsive and domestically affectionate, as the Celt naturally is—open to any tempter who offers a plausible nostrum to cure their ills.

Unhappily, in many parts of the country, where all the elements of industrial prosperity exist, there is an appearance of unquiet; but we are not now obliged to consider troubles which can right themselves, but rather confine our limited time to the discussion of what can be done for the poor isolated folk in Donegal, Galway, Roscommon, and Clare, who must otherwise suffer a continuation of incalculable horrors, until emigration and disease have gradually worked out their extinction.

Panaceas without end have been offered, some as wholesale remedies, others as piecemeal, and with the earnest wish prevailing among Englishmen to do anything towards ameliorating the class in question. Support has been given eagerly, and often without much question as to the practical nature of the projects. In order, then, to consolidate opinion upon some one general plan, I would first endeavour to delineate the exact condition of the people we wish to serve. The small holders, who suffer from periodical distress, hold farms of low valuation, in mostly isolated places, scattered over a large area, and have not the means (if they had the knowledge) of turning their holdings to any other account than potato-planting and grazing. Their stock is limited to a cow, a stirk, a calf, a couple of sheep, and a donkey; and this is exceptional prosperity. They, as in Donegal, often live on a granite formation, far from lime, with no means of transit, never could command artificial manures, and thus must remain trusting to the potato as their staple. As long as the newest potato seed holds sound, these people are, I insist, happy and contented; but the moment the blasted leaf in August heralds the failure of their subsistence, picture to yourselves the dismay and revulsion of feeling which ensues. The stirk and pig were for the rent, together with the few stone of oats on the last potato-planted patch. Anything over, out of this, was to obtain the luxury of a hundredweight or two of Indian meal, and the potato was their mainstay. Winter comes on. The whole family are on the ridge for hours, picking enough "spuds" to serve them for the day; gradually, but surely, this fails, and the stirk and pig are gone ere Christmas comes, the cow soon after, and then—the poor-house or employment; but what state of body is the bread-earner in to profit by opportunity? Is he able to give a day's work for a day's pay, if even on his own farm the chance was given, how much less to walk for miles to a public work, sustained on his share of the dry Indian meal which a shilling will produce for his family of six? I can testify myself to the expenditure of seven-hundred pounds on half-a-mile of road in 1847, which remained for years without the slightest utility, a monument of the "stirabout works," as they were contemptuously called, where many a poor creature died from dragging himself on his swollen limbs to get his name entered on this bogus work. Well, then, planting on a selected hill-side in an Irish winter, where the labourers have miles to walk, and the travel is sufficient exercise for their state, cannot be profitable as a public work, while it certainly does not meet the case of constant employment for a population of half-starved cottiers dwelling miles away; and if the Imperial Government decide upon reclamation of wastes and draining bogs for the purpose of increasing the area for human subsistence, I humbly submit that, in the interests of the people, not less than for the due recognition of the tax-payer, the work shall be submitted for tender, and contracts declared; otherwise it were better to establish general out-door relief at once, with a periodical grant from the Treasury, to supplement the districts when the rates have brought all classes down to one common lot of indigence. In the *Echo* of July 3rd, 1882, there is a leader which contains the following:—

"If all arrears were wiped off, without these poor people being required to pay a farthing, and if they were made a present of their holdings, they would remain amongst the most miserable of mankind. We drew attention, on Saturday, to the report of

the committee of "Mr. Tuke's fund." It will be remembered that, some few weeks ago, a few gentlemen met together at the Duke of Bedford's, and subscribed £10,000 for the purpose of assisting distressed families to emigrate. This money was entrusted to Mr. Tuke for distribution, and it has enabled him to send a thousand people to the United States and Canada, where they may hope to find the comforts and independence they could never have enjoyed in their own country. But how many thousands remain behind on the brink of starvation."

And in the *Times*, in October last, Mr. Mitchell Henry, M.P., thus truthfully gives the stereotyped course of events in existing circumstances:—

"We shall once more be compelled to pose as mendicants before the world, and offer a spectacle of misery and starvation to the eyes of foreign critics, scandalous and degrading to the English name. Empty stomachs beget fierce discontent, followed by crime, stimulated, as it invariably has been, by people who, fairly well off themselves, trade on the undoubted sufferings of the inhabitants of the distressed districts, and under unprincipled guidance, bring about the hideous experiences of the last three years."

Employment, then, must be found; and the ground was broken by my friend Mr. Bevan, when, in 1882, he read a paper, under the auspices of this Society, on "Irish Industrial Resources," since when, the subject has occupied the minds of many men on both sides the water. Happily, at this juncture, a Royal Commission was appointed to inquire generally into the question of technical education, with a secretary to whom any additional labour, whereby benefit was to accrue to any portion of his fellow creatures, was one of love. It has remained for this Commission, of which Mr. Samuelson is the head, to hit upon the real solution, for in the coming report of the Commission I have reason to believe will be found marked out the true panacea for settling the Irish question. I have been privileged to act a subordinate part in developing the idea of the practicability of extending the system of "Home Industries," as existing on the Continent, to Ireland; and I was successful in allaying fears at first generated as to the possibility of establishing anything of the sort in Ireland, from my own actual experience. One point urged was that Irishmen were too mercurial—out of Ulster of course—and that a continuous course of training and work was inconsistent with the Celtic character. To this I replied with the practical test of the Irish pottery which I had the honour of originating and producing. I also called attention to the fact that near a quarter of a century has elapsed since, on a hill in Fermagh, I first found kaolin and felspar, and then and there registered a vow that I would, if I lived, have a china manufacture in the village of Belleek, one of the poorest hamlets in Ireland, filled with ragged children, whose maximum of art lay in the making of mud pies in the streets. I had but to call attention to the fact that the shirtless brats then apprenticed, and commencing manufacturing life by turning the jigger, were now artisans in broadcloth, and receiving wages up to £3 10s. per week—the maximum earned by a splendid young man in the sanitary ware department, taken out of the Ballyshannon workhouse. Well, here is some food for reflection. An amateur mineralogist, dropping upon a raw material on a mountain side, possessed of an obstinate and determined spirit—brought about by searching for and meeting kindred spirits—lives to exhibit these lasting exemplifications of what the Irish Celt could be brought to, and to tell the story of hundreds of youths being lifted from the gutters, to be able to hold their place in a gathering of first-class artisans in china manufacture. Whatever may become of "Belleek" in the future, it has taken its place as a special ware. I don't for one moment bring these matters forward as precedents for Imperial aid in this direction, as the results to myself were worse than *nil*; and when the *Times* sneers at the paucity of imitators in such projects as Belleek, I can only answer that you will find, indeed, few Irishmen so patriotic as to subscribe £4,700, and give three miles of land to secure transit for a contemplated manufactory, having previously given the site and 200-horse power for £3 per annum. No, my experience, if terribly earned, enables me to see that, while it conclusively proves the adaptablility of the Celt to become a manufacturing artisan under the most trying circumstances of isolation from technical training, at the same time, a large and sudden expenditure on forced manufactures would but end in calamitous failure, without touching the circumstances of the only class which requires immediate attention and assistance.

But before going on to make any suggestions as to the method in which the proposal to establish "Home Industries" may be

carried into effect, it may be well to devote a brief space to an account of the one experiment of the kind which has been brought to a successful issue—I mean the manufacture of pottery at Belleek.

The raw material and water power fixed the site, but the Imperial Legislature—which alone in the case of Ireland, of its poor dependencies and colonies, ignores the primary necessity of means of transit—left the position twenty-three miles from a railway station; this involved the question, ruin or abandonment of the project; and here again I wonder I am alive to tell the story of the Bundoran railway, the late Mr. Hemmings, C.E., myself, and the late Mr. Brassey, being the principal parties concerned in this blessing to the district, which involved immense loss to the promoters. And just one word here of that man who I was privileged to call a friend. Mr. Thomas Brassey soon came to know of the difficulties connected with private enterprise in Ireland, but with the straight-forward, manly, and noble nature that knew no deviation from honour and honesty, he carried through the work, and for the hundredth time lent his great talents and position to call forth the regeneration of a country.

Soon, then, began the first pottery for porcelain manufacture that Ireland had ever seen; and never shall I forgot the day when, standing on the foundation stone, I addressed the tatterdemalion lot who assembled, wondering at what was coming; but many a shirtless brat then listening to me lives in a slate house of his own now, and for years since has wanted for nothing, while many more are at the head of their particular departments, and others, again, are gentlemen in America.

Returning home from China, I found the property I inherited, from isolation and continued absenteeism of my immediate ancestors, not in a satisfactory condition. Gifted with some energy and wish to improve, I immediately commenced to examine into the resources of the estate, and in the course of geological and mineralogical researches, I found kaolin and felspar in the gneiss formation. The day on which this took place I decided that, if spared, the water power I had already thoroughly appreciated in Belleek should turn the wheel of a porcelain factory. Travelling like a miller's commercial agent, with a pocketful of kaolin, running after my late friend William Dargan, and everyone possessed of a patriotic spirit, I chanced to fall upon Mr. Robert William Armstrong, the present partner and manager at Belleek, and he, with the late Mr. David McBirney, who found the capital, set to work, and the result has been that I have lived to see a wretched hamlet, inhabited by squalid occupiers of hovels unfit for human life, their only science the use of the tongue and fist, their extent of art a mud pie, grown into a town, with some £60,000 to £70,000 expended in and about it. But this was not effected without the personal labour and loss which must ever attend the exertions of every philanthropist.

The manufactory at Belleek not only comprises the necessary compartments for carrying on the work of a first-rate establishment, but, in the elevation and details, exhibit the head and hands of an architect and machinist who, unlimited by the capitalist, has erected a building second to none in the kingdom; its pediment in plate-glass, and vast masses of cut stone in mixed black limestone and mill-grit, show, in admirable relief, the produce of quarries in the locality; while the magnificent wheel, the work of Sir W. Fairbairn, and the application of every modern machine and appliance calculated to secure the highest results at the least amount of labour, not only render this first attempt at Irish and ceramic production useful as a development of the resources of the country, but combine with it a practical illustration of the progress of science in this relation, giving the best practical opportunity for the apprentice to be advanced to a high pitch of working knowledge on his reaching the position of an artisan. True china is made from the local mineral felspar, as against the soft porcelain of England. Sanitary ware is turned out, against which the proprietors challenge Staffordshire to compete, and decorative, though not extending in its aims to the universally acknowledged supreme head of the world's potteries—Minton—yet evincing a perfection to a certain point which leaves little to be desired; and it is not the least interesting aspect of this new industry to find the artisans holding the middle-class position, and exhibiting it in their clothing, while yet their fathers, never able to emerge beyond their original position of labourers, are still contented with inferior dwellings and dress, complete the contrast between Belleek in 1850 and 1883.

I have dwelt upon this exceptional case of Irish industry not from pride, but solely because

it alone, that I know of, proclaims the aptness of the pure Irish Celt to accept and excel in any new manufactures that may be brought into the country, and because it, I may say, went far to satisfy the Royal Commission as to the looseness of the statements which had been made to them on the subject of Irish incapacity to become steady working artisans. It is true that Belleek is geographically nominally in Ulster, but it is in immediate contiguity to Leitrim, and not far from Cavan, so that as the workmen in the pottery are almost entirely Roman Catholic, and, from consanguinity and local influence, are tempted sorely to a full exhibition of so-called patriotism, it is a proof of the valued employment to exclude the active and perilous side of politics, that the artisans have confined their sympathy to a show of green boughs on a holiday, or a chance song in a public, on the efficacy of wearing that colour.

I have thus alluded to the great pioneer, essential to any amelioration even of the "backwood" farmer's condition. I have not touched upon the national question—the development of the Irish fisheries—too serious a matter for short notice. I will now enter upon the consideration of the last of the remedial measures I propose, "The Development of Home Industries."

The first step towards establishing lasting employment for a people, or for a community, is to find out, and to be practically sure of, a continuous market for its productions. No man of prudence starts any manufacture without having carefully weighed this consideration, and there are various facts to be brought into the argument, before finally deciding upon this matter, even after it has been clearly established to the promoter that a steady demand is possible or probable. In approaching, therefore, the question of employment for the small occupier in Ireland, this question comes equally to the front. We wish to find work for the agriculturist, whose farm affords him neither labour sufficient to fill up his time, nor, in the best of seasons, a sufficient sustenance. The work must be that which does not require a congregating together of the population, but must be possible of completion in the several homesteads. Plant, if required at all, should be simple and inexpensive—in short, not beyond the capability of the mechanic to purchase on the strength of his family production. Therefore, in dealing with the subject before us, we must dismiss from our minds, as impracticable and outside our range, the development of such raw materials as iron ore, coal, or of any substance requiring large capital or a multitude of *employés;* and besides this, the industries must be, with the trifling reserve already indicated, restricted to hand labour.

Were we, then, without any beacon precedent to guide our path, we should almost despair of discovering any means of employing the tenantry in the wilds of Connaught, when we consider that, in this age of invention, it would seem at first sight that capital, machinery, and the facilities of carriage at selected sites, must leave for people so situated as the Irish nothing in the way of production except the work of the agriculturist. Happily, however, there were agriculturists in the midst of other nations similarly placed to the natives of Western Ireland, and the stern reality of the necessity to provide them with a livelihood—gratuitous or self-sustaining—made it incumbent on the Governments of those countries, not endowed with the superfluous wealth of England, to exercise the utmost political ingenuity in thus warding off continual exceptional taxation, and the evils arising from human intelligence contained in an empty carcase. In Austria, then (as now in Ireland) was found a population that was ready to fill up its idle time (two-thirds of the day) in any way calculated to supplement the family's sustenance; and being accustomed to the simplest and commonest diet, neither craved nor required the food which the necessities of a manufacturing commonwealth, owing to the physical exertions normal to extraordinary labour brought into use, and which, from habit, becomes essential. It had by this time (not much more than five years since) been discovered that there were many products which still required, for even moderate perfection (if I may use the term), that a great portion of the labour needed for their production should be "skilled hand labour;" but the people had no natural leaders, and instruction and contact with the market was required. The Government undertook this duty; schools were established; industries fostered; and, as the result, thousands of pounds yearly are paid them by the English and American consumers. Happily, indeed, for Ireland, Mr. Samuelson, M.P., and the other members of the Royal Commission, in the course of their official tour, in search for Continental hints upon technical education in science and art, dropped in upon this busy hive of workers, and thus have I been led into direct contact with this vitally

interesting movement to Ireland. Asked by the chairman (Mr. Samuelson) to give my opinion on the subject as applicable to Ireland, I at once responded to the call, and further set about to investigate the different industries promoted as above, and furnishing the importations into England and America of Continental handiwork.

Some years since, it chanced that a German gentleman, having a large wholesale warehouse in London for women's underclothing, corresponded with me upon the subject of utilising Irish labour, having been informed that I was a likely person to assist him. Therefore, the moment I commenced my work, I renewed my acquaintance with him, and whatever success may come of Mr. Samuelson's idea, Mr. Charles Bayer's name must be associated with its advent. I had much to ask, and hoped to see much, but I never imagined that my visit to this one establishment would have at once forced upon my mind the conviction that it would be an absolute calamity to both countries, Great Britain and Ireland, if the Imperial Government delayed acting upon the paternally-inspired precedent of the Austrian and other Continental Governments, and failed to afford to its Irish subjects an opportunity of sharing with their foreign rivals the supply of the insatiable markets of England and America.

Bale after bale, case after case, developed before my eyes the fruits of the foreign peasant's labour. First, corsets for the million, from Wurtemberg, produced thus:—The middleman between the London merchant and peasant worker distributes yarn, through his agents, according to the available labour in the family, and this is woven in a simple hand loom, costing but forty shillings, to the requisite size; a little coarse embroidery on the breasts completes the work at the homestead. It is then returned, and is "blocked and boned" by the dealer, and prepared for market. Fine flannel, kerseymere, and other beautiful kinds of cloth, in other articles of ladies' clothing, were shown me, just returned from Switzerland, with the addition of exquisite and tasteful ornamental embroidery, not only having to bear the charge for the peasants' labour, but having the additional cost of the duty upon cloth on entering the Republic—a proper penalty for thus perversely ignoring the willing and itching hands in the homes of Irish fellow-subjects, whose employment was called for as much by self-interest as by natural ties. Next, brilliant crimson knitted petticoats—the 14 ozs. of wool supplied being turned by the peasant's work into a garment sold for 7s. 6d. Hear this, O ye crones of Connaught, sitting in the ingle with folded arms, and think what a "haporth" of iron between your fingers might do for the family, and "caleying" going on all the same! But to proceed. Linen and calico, muslin and lawn, all make the foreign tour, and return to enclose beauteous forms in multiplied surroundings, the names of which the pen of man must not record. Just one package, and that the last, offered me some consolation, when Mr. Bayer declared it to contained the work of girls in the county of Londonderry; a proof of the ability of the Irish lass to rival the mädchen of Germany. These, to me most interesting habiliments, were enclosed in a stout, commodious basket, and before I turned from this practical evidence of Irish capabilities, I asked its history. "This basket," replied Mr. Bayer, "was made in Leicester, being purchased there wholesale at 30s. each; it comes to me by the Midland Railway, and then, filled with the ready cut-out clothing, it is dispatched to Ireland, and returns with the marketable commodity." This set me off on the investigation of another industry, thinking as I went, what a downright sin lies at the door of some one. Here is as rough a piece of wickerwork as need be, bearing a fabulous price, sent to Ireland—a country with an atmosphere and soil made for the growth of willows, and every man conversant with the construction of creels. "Coals to Newcastle," indeed, one would think; and, thus musing, I found myself at Covent-garden, and in the warehouse of a wholesale dealer, principally in English baskets. He was not half satisfied to give me information when he found my tongue did not pronounce "Shibboleth" in Anglo-Saxon style, but, rubbing him down the right way, I found he paid 8d. per hour to his men as a minimum, and up to 1s., and he spurned the idea of either Irish or foreign peasant ever being able to interfere with the strong basket trade, however they might (and he confessed, in the case of the latter they did) compete successfully in the more delicate descriptions of baskets. Asked whence he procured his rods, he replied, "Some are English, more foreign, none from Ireland."

In the course of my peregrinations of inquiry on this home industry question, I came upon a man mending the bottom of a chair, with a bundle of rushes by his side. He worked

smartly, and the result was capital—a strong, soft seat. Upon inquiry where the rushes came from, he said, "Holland," and complained bitterly of the retailers "running the bull upon him," which turned out to allude to an adulteration of the long, flat rush—which is the preferred article—by mixing bulrushes of English growth in the bundle, for which latter he had paid no less than 2s. 6d. I afterwards found that all kinds of rushes are turned to account abroad, and manufactured into surprisingly useful articles by the enterprising foreigner.

My next visit in pursuit of baskets was to a town forty miles from London, where I found 2s. 6d. the average day's pay of a stripling basket worker; and, driving in the vicinity, I discovered that in every little dell where moisture existed, pollards of osiers stood, yielding on an average twenty rods from each crown yearly. These, planted three feet apart, with a certain average price for the rods of 1s. for 120, returning just £40 per statute acre. Had the soil of the whole farm suited, what crop would pay better? Thus far for England's basket manufacture. But who shall say the amount of basket work that comes into London yearly from Germany and France? Walk through any street of shops in the metropolis, and count those exhibiting the marvels in wicker-work for ornament and use, all the production of the foreigner; inspect the stock of such a wholesale house as that of Mr. Burluraux, in Tavistock-street — and dwell upon the thought that there is not a farm in Connaught or Donegal, held by the class we seek to benefit, which would not yield, after one year's planting, proper osiers worth £10 to £15 per Irish acre per annum, nor is there a cabin in which we could not find hands that, in twelve months' time, would rival the work of the average Continental wicker-worker.

It would be tedious to name here all the trades which, owing to the establishment of the foreign Government schools, have inundated England with the results of home industry. Not a possible raw material has been neglected, while large fortunes are made and making in the importation of rods and rushes. One kindly gentleman, having a large warehouse in Petticoat-lane, who gave me much information on this head, told me he bought largely in England, had a withy bed of his own not far from London, and had just purchased one—to him—little consignment of forty tons of foreign osiers.

Suffice it to say that the following are some of the industries, engaged in by the Continental peasants, whose products are imported in a very large quantities:—Toys in wood and metal, mosaic work, straw-plait, wood-carving, furniture, marble polishing and cutting—the latter exhibiting in table ornaments the best advertisement of the local geology. These all combine to show that the resources of the countries are truly developed to the minutest detail, while the peoples are trained to use their every moment in the exercise of brain and hands; experience rapidly developing the utmost value from both; and—as to the results in a social point of view—hear a friend, just returned from an examination of the homes—"Trim, neat, and even picturesque cottages, beautifully clean both within and without; no cottage without its flower garden, and a few bright flower pots in every window. What a contrast to Western Ireland, where I never saw a cottage garden!" No greater contrast than the present dwelling above pictured and that in the same locality some years since.

I have now portrayed the present position of affairs in Ireland. I have shown, mayhap with too much bluntness, where she has reason to complain — as a dependency completely at the mercy of the Imperial rule—of the neglect of her means of transit. It now remains only for me to show how easily and economically the foregoing industrial precedents, successfully tried elsewhere, can be applied to Ireland.

The Government, in its prevailing anxiety to raise the moral status of the masses and advance the culture of the country, has established in South Kensington a department for the administration of a yearly grant, now amounting to upwards of £160,000, for the furtherance of science and art. Through classes connected with the National and other Schools, about £8,000 of this sum is expended in Ireland; we have, therefore, here the nucleus for any extension in the direction of technical education. By the appointment of a man conversant with these foreign precedents, as special manager (under the South Kensington Department), and with an Irish grant for the instruction of the people in home industries, the administrative requirements on one side the channel are nearly satisfied. It would be necessary to have a corresponding official in Dublin, with a small office, and to appoint district committees on the lines, say, of the Medical Charities Act, with clerics added. These would constitute the corresponding authorities in the districts.

Their duties would be to provide premises; to select (with the sanction of the Government agent) the industry best suited to the locality; and generally to supervise the business in the country, the Government providing and paying the salary of an instructor, and giving premiums for exhibited results. An Imperial annual grant of £20,000 would, I estimate, be sufficient to carry out this important experiment upon a fitting scale.

I have now demonstrated that the market exists, and also a demand to any extent, on the lines of competition with the Continental producers, who are now weighted against the Irish in the race by their more costly living, and probably also by the cost of transit. As to raw material, in the case of the gigantic trade in basket work, twelve months' growth suffices to supply the home industry, as well as to compete with the Continent in the supply of rods. In textile industries, the same impulse of requirement which induces Mr. Bayer to offer hand-looms and stitching-machines on deferred payment (if my plan of responsible committees is adopted), together with fabrics and yarn, up to the amount of his trade, will surely be present in the case of hundreds of other merchants similarly situated; while the philanthropic owners of thousands, ever ready to aid the Irish in their extremity, hitherto bemoaning the barren results of their charity, once convinced of a move, instituted by Government, towards making the population self-supporting, would not fail heartily to supplement the effort, in aiding the districts to plant willows, provide houses, and supply raw material, where required in the incipiency of the movement. Here, then, is a plan, simple and inexpensive, whereby for a small yearly outlay the foundation of a new social state may be laid in Ireland, wherever the small and impoverished half-fed occupier is to be found.

But who shall tell the great results in the future which might not spring from these beginnings? Once satisfied by undeniable evidence that habits of thrift, and industry, and a sense of independence, have been engendered, nervous capital, reassured, would soon find its way into the wilds of Connaught, and industries, beyond the powers or the possibility of Government initiative, would spring up and proclaim the fact that Ireland had at length entered into the sphere of manufacturing nations. The earnest advocacy by Dr. Cameron of the cultivation of rye in our sympathetic soil would ere long receive attention, and while the grain would furnish the needed sustenance to our new race of artisans, the straw, manufactured at little cost into pulp for the paper maker, would constitute a valuable material for export, or would be used as on the Continent in the industry of straw plaiting, for which it is esteemed, beyond all others, either whole for grosser work, or split for the finer productions. Bogs would receive their proper treatment, whether as producing fuel, or as providing sites for plant and tree culture; water power would be employed in turning district woollen mills, and in storing energy to be used electrically in every busy homestead, or in conveying the necessary supplies of manure and sustenance to the most remote districts, by means of the narrow gauge electric railways of Dr. Siemens. Thus in time would the people, by the sure instinct of happy experience, be brought to realise the fact that on British connection, and on that alone, their sure welfare depended.

DISCUSSION.

Mr. Wm. Botly said that little could be done for Ireland until there was a greater development of her home industries. In some parts of the country, however, he had found a considerable investment of capital. Ireland was adapted for the growth of flax, which he was sorry to see was decreasing in amount; and oats also grew well, though the country was better fitted, as a rule, for pasture. It was better adapted for cattle than for sheep, and in both these branches of agriculture the statistics showed a decrease. Some people said it was not a good country for sheep, but he had seen sheep there which would do credit to any of our best English breeders. Some beautiful specimens of art had been exhibited by Mr. Bloomfield, and he had seen in the house of Mrs. Dargan, widow of the gentleman alluded to in the paper, other examples of very great beauty.

Mr. Bagnall said he had had the pleasure of visiting the factory at Belleek some two years ago, and he must say that Mr. Bloomfield had not brought the finest specimen he could have selected. He could vouch for every statement which had been made as to the improvement of the population through the establishment of this manufactory, which was a proof of the good effect of habits of industry. Ireland would never progress until her people made more advance in the industrial arts, and that principle once being admitted, he thought it was the bounden duty of the State to take some steps in this direction. In his opinion the political question of Ireland was much affected by the inferior condition of the people socially, and if their material comfort and educational status were improved, the political

difficulty would soon disappear. Allusion had been made to the artistic faculties of the Celts, but it was only necessary to look around that room and see the magnificent paintings on the walls, which were the work of an Irishman, James Barry, to recognise that Irishmen had the artistic faculty in the fullest degree. The objection which would probably be made by English philanthropists to the suggestions now brought forward, would be that they would cost a great deal; but even if they did, it might be worth while to try them. It was obvious that capital could not be better laid out than in pacifying Ireland. England protected her own industries at the expense of Ireland in the last century, and then, when the Union was accomplished, and free trade established, Ireland had suffered more from it than any nation in the world. If there was a case where a nation ought to come forward and make reparation for past misdoings, it was in the case of England and Irish industries. It might cost money, but England would not only be repairing past wrongs, but would find it a very good investment. The practical results of technical education would take some time to show themselves, but they would sow the seeds of future prosperity, for he defied any one to say that Irishmen were deficient in intelligence, or that they could not learn a trade as quickly as an Englishman. Being an Irishman, he took an interest in his own country, and he thought the best thing England could do for Ireland was to teach her population how to maintain themselves in comfort.

Mr. Edward J. Watherston said that there was a good old saying, that "industry and capital are the wheels of the car of contentment and prosperity." However, capital was dependent upon contentment; therefore it behoved statesmen to use their utmost endeavours to provide by just laws for that contentment, without which prosperity could never be forthcoming. Unhappily, no peep into the future of Irish industry was possible without due consideration of the past history of Ireland in connection with her industries. It must not be forgotten that industry was stamped out of Ireland by the cruel laws of England, principally in the reigns of Charles II., James II., and more especially in that of William III., and Mary. Thus it was that cattle, meat, leather, wool, woollen manufactures, and everything else were forbidden to be exported to any place on the earth, under pain of forfeiture of the cargoes, and £500 fine for each offence. True it was that this state of affairs ceased at the time of the Union, but Ireland had never recovered from the poverty which had resulted from this legislation. Englishmen, recognising the great wants of Ireland, should consult together how best to develop industry in the sister island. There were now three great industries in a highly prosperous state, viz., linen, brewing, and distilling. In minerals, Ireland was not rich; but excellent quarries were to be found in many parts of the country; slate also. As respects her clays, the reader of the paper told them about the well-known "Belleek" ware. Irish bricks are of very excellent quality, and, but for the enormous charges for transport, would compete successfully with English makes, those of Tullamore, Athy, Clondalkin, Kingscourt, Bray, and Kingsdown, being of first-rate make and finish. Another clay industry could be developed—Portland cement, made of hard limestone and indurated clay, containing a large proportion of lime. Artificial manures and paper could also be produced in Ireland. But, foremost of all possible industries, were the salmon fisheries and the deep sea fisheries, as respects which the Government could immediately lend a helping hand, by improving the harbour accommodation, and the system of transport. The railways of Ireland were a crying disgrace to the United Kingdom. Many were in a state of hopeless bankruptcy; nearly all were conducted upon a principle "how not to do business." He referred to the statistics relating to the "fishery" trade and railways, and argued that the latter should be placed under "unity of administration."

Mr. Liggins thought the paper was in some respects unsatisfactory, inasmuch as the only two industries recommended were pottery—of which some beautiful specimens were exhibited—and the growing of rushes. But if they could make that pottery in Ireland, why did they not at once send it to the nearest market, where a good price could be got for it; and if the soil was suitable for growing rushes, why did they not at once go in for it, and supply Germany, France, and England with baskets. England received gladly anything produced in Ireland. The largest supplies of butter came from Ireland, and also milk, cheese, poultry, and sometimes cattle. He was surprised that no allusion had been made to some of the really great industries of Ireland. Poplin was an Irish article, and in his opinion, a lady never looked so well as when dressed in poplin. He would pass by lace, though it must employ a large number of hands; but the shipbuilding and linen industries of the north of Ireland were carried on on a very large scale, and there we did not hear of discontent and disorder. A friend of his was proprietor of one of the largest mills in Belfast, and he had no difficulty in getting people to work for him at fair wages. Only that day he had heard that the shipbuilding trade of Belfast had doubled within the last year. The figures for 1881 were 13,893 tons, while those for 1882 were 28,120 tons. Messrs. Halford and Wolf were now building sailing ships of over 4,000 tons, a thing unknown either in London, Liverpool, or on the Clyde; and they were also builders of the White Star liners, which were amongst the finest ships which crossed the Atlantic. The prosperity of a country depended on the energy and skill with which her richer men applied their capital and intelligence, and he did not see why Ireland should come to England and ask for assistance. It was all very well to say there were not sufficient railways;

but if the trade increased, why did they not make more, and double the single lines when necessary. But when the Irishmen made their railways, they adopted a different gauge to the English, and that was the great obstacle to bringing fish from Ireland, because it would not pay to trans-ship them twice on crossing the Channel. The fishing industry of Ireland was certainly not developed as it ought to be. He had been in Kingstown harbour, and seen hundreds of Cornish fishermen there wind-bound with cargoes of herrings caught in Scotch waters, which they were taking to English markets. Why should not all the fish be caught by Irishmen in Irish boats? The seas all round Ireland teemed with fish, and there was no reason why it should not be caught, salted, and sent to the Mediterranean ports, as it was years ago. As an Englishman, he should like to see all their industries flourish; and when he thought of Thomas Moore, Sullivan, Balfe, and many other authors, poets, and sculptors who came from the sister isle, no one would dream of denying them either intelligence or artistic ability.

Mr. MARTIN WOOD said it was idle to contend that there was the capital in Ireland which was required for industrial development. He regretted that the paper read there by Mr. Phillips Bevan last year had not produced more practical results, and the great question was what would be the practical result of this one. Mr. Bloomfield was evidently of opinion that the State ought to come forward, in some way, to assist; and, in spite of all that had been said about self-dependence and so forth, it must be admitted that something should be done in that direction. £20,000 was named as the sum necessary for establishing technical schools, and he saw no reason why that, at any rate, should not be tried. On the Continent, the State assisted in this way to develop the industries of the various countries.

Mr. QUINLAN said he was opposed to grandmotherly treatment, and he would not give a grown-up man protection, thus treating him like a child; but, on the other hand, he would not turn out a child into the street to fight the battle of life for itself. On the same principle, there were cases where protection was necessary, and business in Ireland was in a state of childhood; and required some protection on the part of the State until it arrived at a further stage of development. He had made some study of business, to ascertain why one man or one country succeeded, and another failed, and he came to the conclusion that success depended mainly on certain conditions. You must have capital, good management, a good staff, and the necessary materials. He had lived in every part of Ireland except Connaught; and he might say that in the north there was a large manufacturing business, which was, in the first place, created by the Government. The linen trade was originally created in that way, and was never stamped out by subsequent legislation; the consequence was that in the north the people were contented and loyal, as they would be in the south under similar conditions. Ireland was deficient in capital, and he must say that she had not had good management. Special means had not been taken to establish or to foster her industries, as was done in continental countries. Were the people capable of being made into good workmen? He had had considerable experience of workpeople, Irish, Scotch, and English, and he had found the Irish equal to any, if they had fair play, and a prospect of some recompence for their labour. In England and America, he had seen his countrymen as successful as anyone else. Lastly, as to the materials for a successful business. Ireland had abundance of water power; coal, though it was not worked, for want of railways; and mineral resources. Mr. Bevan had shown that, and those who had studied the subject knew that she had them in much greater abundance even than he had stated. Ireland, therefore, had all the requisites for becoming a manufacturing country, if there were any organisation for the creation and fostering of her resources.

Mr. SCOTT expressed his regret that some such paper as this had not been read some fifty years ago, at the time when England was starting on her career of industrial prosperity, in order that Ireland might have had a chance of sharing it with her.

Mr. J. B. ROGERS thought the main question raised was how to provide employment for the people in sparsely populated districts, and suggested that the flax industry might be greatly developed.

The CHAIRMAN said it must be borne in mind that it was not Ireland alone which was now asking for technical education. England was just as anxious for it, and found it just as necessary. Trade in various parts of England and Scotland had been for a long series of years flourishing, but a cloud had of late come over it, and one of the reasons assigned was a deficiency in technical skill on the part of our artisans. The prosperity of Bradford had been greatly interfered with by the superiority of the manufactures in other parts of the world, and by changes in fashion, and Bradford had now set to work to found a technical school out of its own pocket. He was glad to say that a similar attempt was being made in Belfast, and he was sure that in so doing they would have the sympathy, and possibly the material support, of many persons in England. He had never encouraged the Irish people to look only to Government aid for that which was to be done to develop their industries. He had taken a humble part in attempting various industries in Ireland, and in many instances the very moderate amount of success attained had been somewhat disheartening; but, at the same time, they were not wholly unsuccessful. For instance, in Galway, where there had been, and was still, a large amount

of destitution, a number of gentlemen some years ago established a jute factory for making the coarsest kind of canvas, which had proved very successful, and had rescued a great many from idleness and starvation, though it had to encounter very keen competition. He valued the paper principally as showing practical evidence of the utilisation of the resources of the country. In reply to Mr. Liggins' observations, he could only say that Mr. Bloomfield did send his manufactures to England, and the more Englishmen would buy, the better he would be pleased. One of the latest developments of Irish industry were the beautiful artistic productions of Marcus Ward and Co., of Belfast, which had a very large sale, and he did not consider the out-look altogether hopeless. Mr. Watherston had referred to Portland cement as an article which might be manufactured in Ireland, and knowing, as he did, of a manufactory on the banks of the Liane, near Boulogne, with a capital of two millions, which had sprung up within a few years, he only hoped that a company would soon be formed for introducing this industry in Ireland. He could not say that poplins were ever a principal industry there, and unfortunately they had very much gone out of fashion, and the makers were in rather a depressed state, but they would be very glad to increase their manufactures if the English public would buy them.

Mr. BLOOMFIELD, in reply, said his paper had no political animus; but, at the same time, he was very anxious to strengthen the hands of a responsible party who were seeking to give the poor people of Ireland the same system of education as had been found so useful on the Continent. He would point out that Mr. Liggins was quite mistaken in saying that he had only recommended pottery and rush growing, he having stated distinctly that the pottery had not proved commercially successful. Flax could not be profitably cultivated by small farmers; any attempt to do so would destroy the farm in two or three years. He had only brought the specimens of pottery to show that the Irish were capable of real artistic work, if it was required. He hoped the report of the Royal Commission on Technical Education would result in such measures being adopted as would tend to develop the industrial resources of Ireland; and he was quite certain that no better means could be devised for putting an end to discontent and crime.

The CHAIRMAN then proposed a hearty vote of thanks to Mr. Bloomfield, which was carried unanimously, and the meeting separated.

Miscellaneous.

COMMERCE, INDUSTRIES, AND RESOURCES OF OMAN.

The United States Consul at Muscat has lately issued a report upon the commerce, industries, and resources of Oman, which the Department of State has published, and called particular attention to, as "being rendered doubly interesting by reason of its dealing with a district and people very imperfectly known to commercial communities." Oman is a country situated in the south-east of Arabia, between the Persian Gulf and the Arabian Sea, or Sea of Oman, and forms the central part of the Muscat Dominion. Its agricultural products are considerable, but limited in quantity, owing to the unfavourable nature of the country for vegetation. The labour attending production is very great, as, on account of the small annual rainfall, which seldom reaches six inches, the inhabitants have to supply artificial irrigation by means of wells and "felegs." In the former case the water is drawn up from a considerable depth by means of a bullock, and a leather bucket or bag, which, when emptied into a small reservoir at the surface, runs along the channels prepared for it, to the section to be watered. This system prevails principally on the Batinah coast, whilst in other parts of Oman the "feleg," or conduit system common to Persia, is to be met with, though it is generally a monopoly of the wealthy. The cultivated patches are usually some distance apart, and where wells can be sunk, in the plains of the vicinity of Jebbel Akhdur and in El-Dha-hiveh, the crops are more abundant, but extensively cultivated tracts of land are unknown. The soil is exceedingly poor, and hard and caked in appearance. The cereals, fruits, and vegetables grown in Oman, in their respective seasons, are as follows:—White and red wheat, gowaree, maize, barley, small quantities of sugar-cane—from which a very inferior description of sugar is made—dates (of which there are at least forty varieties), mangoes, figs, vegetable marrow, bananas, sweet limes, lentils, grapes, apricots, peaches, tamarinds, mulberries, quinces, potatoes, guavas, citron, onions, limes, oranges, radishes, cucumbers, almonds, plums, spinach, pomegranates, pumpkins, apples, &c. Of these, the date is the most valuable, and trees are cultivated in every available spot suitable to their growth. Groves of these date trees extend along the Batinah for a distance of 200 miles, but owing, it is supposed, to the saline air nature of the soil, they do not retain their colour. This is not the case with those grown in the Ishmailee and Sharkeyah districts; these are largely grown for exportation, in fact it has been proved that no other description will stand a long sea voyage. These are pressed into mat bags, on the spot where they are grown, and brought into market on camels, when each bag is carefully cut, examined, weighed, and the dates again placed in bags, before shipment. The same dates, but not pressed, called "nuther," are brought loosely in baskets from the interior, and after selection, are packed in ten and fifty pound boxes, and shipped. The Batinah or donkey dates are the cheapest kind, and form the staple food of the poorer classes of the inhabitants. A prolific date tree, under the most

favourable circumstances, will produce from two to three hundredweight of dates in a season. Date stones, when boiled down with fish heads, old date baskets, and other refuse, is largely used as food for cattle. Pomegranates and limes are largely exported to India. Rice is not grown, and cereals are only cultivated in a small degree. The rotation of crops is very imperfectly understood. The farm implements in use are ploughs, harrows, hoes, sickles, and threshing machines, all of very primitive and rude form. The threshing is performed sometimes with a light kind of flail, but generally a heavy log is drawn over the corn, and cattle are driven over it. Manuring is carried out to a small extent only, fish, and cattle litter being the only manure known. The manufactures and industries of Oman are insignificant, and with the exception of textile fabrics, "kharak," or dried dates and salt fish are only for home consumption. The most important industry is the preparation of dried dates, called by the Arabs, "bisir," which are largely exported to India, where, under the name of "kharak," they are a necessary ingredient at certain Hindoo festivities. The variety from which they are chiefly prepared is the "mubsoli;" but the "khuneyzi" is also sometimes employed. The process observed is as follows:—The dates are picked before they are quite ripe, and put into copper cauldrons, filled with boiling water, when they are allowed to simmer for half-an-hour, until a certain quantity of the juice is extracted; on being taken out, they are put in the sun for two or three days, and continually turned until they are found to be quite dry and hard, when they are packed for export in mat bags. The house in which the boiling takes place generally contains five or six boilers, capable of holding about five gallons each, and has a chimney about fifteen feet high, to increase the draught. As the water in the boilers extract the juice, fresh water is added until it is too thick to be longer used, and it is then put aside to be fermented into liquor. The earthenware used in Oman is almost exclusively made in the country. There are several potteries at Nakhl, Funja, Rostak, Saham, and Multrah. The potter's wheel is much the same as in other countries, a low horizontal wheel being generally used, on the centre or axle of which a lump of wet clay is fashioned by the hand as the wheel spins. The pots are coloured with Indian red, and burnt in a kiln. Toys are also made of clay. Next to agriculture and the date cultivation, the fisheries form one of the most important industries in Oman. The Oman and adjacent waters abound with fish, comprising, among other varieties, the seer, bonita, shark, sword and saw fish, and sardines. Immense quantities are exported, and nearly the whole of the coast population live entirely upon fish. At Muscat, and some places in the Batinah, the fishermen are generally Belooch and Persians, in other parts they are Arabs. During the pilgrim months, the fishermen go to Jeddah to fish, attracted by the high prices prevailing there at the time. The nets used are the cast and the seine, besides lines and trap baskets. Large quantities of salt fish are sent to Bombay and the Malabar coast for consumption and re-export to China. The method of salting practised now in Oman is of the most primitive kind, and entails a large amount of waste. It is estimated that about 2,500 boats and 20,000 persons are employed in the Oman fisheries. As regards the trade of Oman, it is impossible to obtain reliable information respecting the imports, owing to the manner in which the returns are kept at the Custom-house—the customs being farmed annually to the highest bidder, in whose interests it is to show the smallest returns. It is well known, however, that of late years the trade and population of Muscat has been declining, owing to the insecurity of the country from the raids made by the Bedouin tribes. The exports from the interior of the country are principally brought by caravans to Muttrah, a town distant about two miles, and are carried from there by water to Muscat, and in the same way the imports are conveyed back, native craft being used for the purpose. All supplies from the interior are sold to local merchants at Muscat and Muttrah.

THE BLEACHING OF PARAFFIN.

M. de Molon's patent process of bleaching paraffin (as described in the *Corps Gras Industriels*) is said to be more rapid and less expensive than the older methods, while presenting the additional advantage of incurring none of the waste which has been alluded to. It consists, in the first place, in the filtration of the rough paraffin, which is subjected in a boiler to the action of lime, there being added about five per cent. of its own weight of sulphide of sodium and water. The mixture is let cool in order to allow of the solidification of the layer of paraffin; it is then washed with boiling water and then pressed. The sulphide of sodium may be replaced by ten per cent. of lime in powder. After boiling for an hour, the mixture is filtered, and is treated as above, with amylic alcohol. The residues from these operations are preserved in order to be treated subsequently by an acid—for instance, hydrochloric acid, or sulphuric acid. The action of these acids is to form with the base a salt, and consequently to liberate the carburetted oily substances. The paraffin and the amylic alcohol are then set free by the process of distillation.

The inventor of this system remarks that in place of sulphide of sodium and lime, other sulphurous combinations could be used. It is further stated that, after the performance of the operations which have been described, the action in a suitable apparatus of sulphuret of carbon, of amylic alcohol, or other dissolvents, can be substituted for the filtration by means of animal charcoal, which has

hitherto been customary. Care should be taken that the liquid intended to be used in the filtering process should be made as cool as possible. After this treatment has been carried out, the paraffin has only to be filtered and pressed before being delivered to the trade.

THE AMERICAN COTTON INDUSTRY.

An organ of the textile trade in Germany lately published a treatise on the influence of the American cotton industry on the markets of the world.

The number of spindles in the United States is now estimated at 15,000,000, of which 3,000,000 have been added during the past year. The annual profits of the factories are stated to have been, on an average, 22 per cent., notwithstanding the unskilled organisation and direction of the establishments in the Southern States. The conjecture is hazarded by the German writer, that the number of spindles will, in five years, increase to 40,000,000.

The production of the 12,000,000 spindles in the United States in one year represented a value of £45,000,000, while the out-turn of the 39,000,000 spindles in England was worth £110,000,000. In America, 181,000 workpeople were engaged in the industry represented by this production, the corresponding number in England being 486,000.

From these facts, it is argued that, as soon as export trade becomes really a leading feature of the American cotton industry, the competition which other nations will experience from it will be of the most serious character. The factories in the Southern States of America have been working day and night to keep pace with the demands of consumption; and it is also stated that every spindle in America represents an annual consumption of 65 lbs. of cotton, against one-half that quantity in the case of the spindles in England.

UTILISATION OF DISEASED POTATOES.

M. Bourlier and M. Hervé recommend the following measures to be taken with diseased potatoes as soon as they are raised from the soil, with a view to utilise the tubers, and also to prevent the disease from spreading to future crops:—(1) Boil the diseased tubers in cauldrons on the field, ram them tight into pits, with the addition of ½ per cent. of their weight of salt, and cover them with eight inches of earth; (2) burn the haulm on the spot, so as to destroy any sporules that they may contain; and (3) never leave on the ground any diseased haulm or rotten tubers, which might propagate the disease. The above treatment only adds about 7s. a ton to the cost of harvesting; and the potatoes, thus treated, may be kept for several years, affording excellent food for cattle, who are very fond of it.

Correspondence.

THE ANTISEPTIC ACTION OF SPONGY IRON.

The Society's *Journal* of March 9, contains a communication on the "Chemical Analysis of Drinking Water," in which Mr. Jabez Hogg renews a discussion which, it might have been expected, was carried far enough at the Institute of Civil Engineers to prove that he made a mistake. As he admits, he employed water for his experiment which was taken from an ordinary domestic spongy iron filter. This has at its base a receptacle for filtered water, which, as usual, communicates by an air-pipe with the outer air. Whenever filtered water is withdrawn from the tap, air is sucked in through the air-pipe, and comes in contact with the filtered water in the reservoir. The air is full of germs of bacteria; Dr. Tyndall has shown that it is soon deprived of those germs when in contact with wet or moist surfaces; nevertheless, Mr. Hogg expects that the water in the reservoir should remain free from bacterial life.

Once more I beg to refer him to my papers read before the Royal Society (No. 180, 1877, and No. 186, 1878). The following passage will there be found with reference to the apparatus employed by me, in my experiments on the antiseptic action of spongy iron:—"Into opening, *c*, a tin tube is fixed, which is first bent upwards, and then downwards, in the shape of an inverted **U**, to prevent any bacteria, or their germs, from passing through this outlet-tube into the bottom of the vessel. The air-pipe, *d*, down to *c*, is filled with firmly compressed cotton-wool." How can the difference between an ordinary domestic filter and the above arrangement—the details of which will be self-evident to anyone conversant with such experiments—escape Mr. Hogg's observation? If he wants a fair scientific investigation, why does he not repeat my experiments, or those by Mr. F. Hatton, or, if he sees any objection to them why does he not point it out? Though he is not, apparently, sufficiently impressed by the importance of all the little niceties which are indispensable to the successful carrying out of such experiments, there is a fair chance of his obtaining the same results as Mr. Hatton and myself. If so, he would find it rather difficult to reconcile these results with the opinion expressed by him in the Society's *Journal*. Or, if those experiments do not suit him, I venture to propose his preserving some well-made butter under spongy iron and water. Should he then, as I at the present moment, find the butter fresh after four years' keeping, he would, I think, be forced to admit that wet spongy iron has a strong antiseptic action.

Mr. Hogg's reasoning is as open to objection as his experiments. When his attention is called to the inconclusiveness of his experiments with water from an ordinary domestic filter, he exclaims:—"My answer to objectors on these grounds is simply that

it is part of the filtering process as pursued at Antwerp, to expose the water, after it has passed through the spongy iron, freely to the air before it is delivered to customers." That is quite right, but surely Mr. Hogg does not seriously mean to make spongy iron responsible for any contamination *after* filtration; he does not mean that, because water has once been passed through this material, it is reasonable to expect that it should for all time remain germ-proof!

In my opinion the most prominent object of a filter is to destroy certain specific poisons, such as those of typhoid and cholera, which may have entered the water *before* filtration. Of course common sense tells us that we ought to guard the filtered water as far as practicable against re-infection of these poisons. Thus I have made special provision in filters supplied to the India-office, which are sometimes used in cholera wards. In these the infected air is purified by filtration before being sucked into the reservoir for filtered water. Similarly at Antwerp the filtered water is guarded against infection by all possible means, such as covered reservoirs, &c. However, as regards re-infection by ordinary bacteria of putrefaction, to which water after filtration is always exposed in the daily use of filters, Mr. Hogg overlooks that it has little hygienic significance, because all natural waters, without exception, contain these organisms, and no one will dispute the wholesomeness of many natural waters.

I have, nevertheless, experimented upon the bacteria of putrefaction, and not upon the specific germs of disease, because, as Mr. Hogg is well aware, the specific germs of disease, which are propagated by water, such as cholera and typhoid, have not as yet been isolated. However, to use Professor Huxley's words, there is every reason to believe that these diseases are caused "by bodies of the nature of bacteria." My inference therefore was, that if the one be destroyed by the filtration, the other is also likely to be rendered harmless. Practical experience, which is the most crucial test of all, has already largely supported my conclusion.

To my regret, I cannot in any way agree with Mr. Hogg that the gelatine test has as yet a claim to be accepted as conclusive. He is well aware of my objections to it, not one of which has to my knowledge been removed. However, if the experiments with the gelatine test proved anything, they have demonstrated, on Mr. Hogg's showing, that by filtration through an ordinary domestic spongy iron filter, the very indifferent water of the Manchester supply was rendered physiologically as pure as distilled water, unless the latter be prepared with special precautions. Let us, therefore, hope that my objections to the gelatine test may prove unfounded, and we thus be enabled to rely, more than I feel justified at the present moment, upon the excellent testimonial it has given to the antiseptic action of spongy iron on water.

GUSTAV BISCHOF.

4, Hart-street, Bloomsbury, W.C.

Obituary.

MR. ASHTON WENTWORTH DILKE, who died at Algiers on Monday, 13th inst., at the early age of 33, was elected a member of the Society of Arts in 1859, his father, Sir Charles Wentworth Dilke, being then a vice-president of the Society. Mr. Dilke was a scholar of Trinity Hall, Cambridge. Soon after leaving the University, he travelled extensively in both European and Asiatic Russia, and thus acquired a very thorough knowledge of the Russian language, which led him to make some translations from that language. He was elected Member of Parliament for Newcastle in 1880, and delivered his maiden speech on the second reading of his Bill for extending the hours of polling at Parliamentary elections. Mr. Dilke's health had been failing for several years, and at the beginning of the present Session he resigned his seat. He was proprietor of the *Weekly Dispatch*, and the author of several articles in various literary journals.

General Notes.

GOLD IN AUSTRALIA.—The production of gold in Australia seems to have diminished considerably since 1875, when the mines yielded 1,068,418 ounces. In 1876, the quantity sank below a million ounces; that is to say, to 963,760 ounces. In 1877, the figure fell to 809,653 ounces; in 1878, to 758,040 ounces; and, in 1879, to 758,947 ounces. The year 1880 showed a slight improvement, for the yield rose to 839,121 ounces; and 1881 was still better, with 858,146 ounces; although the quantity was far short of a million ounces.

ASBESTOS.—In Italy, the working of asbestos is at present limited to the provinces of Turin and Sondrio. In the latter, the asbestos forms regular statifications, varying from 364 inches thick, although, in some cases, it attains 20 inches. The rocks enclosing it consist of talc, chlorite, or steatite, of a green colour; and the asbestos is chiefly found in fibrous masses of a yellowish white. Sometimes the fibres are long and close, resembling a skein of cotton thirty inches long. Asbestos abounds in the fissures of serpentine rocks, and is frequently mixed with other minerals. Openings have been made at forty different places; and the enclosing rocks being generally blasted. When the rocks are of too considerable volume to be removed in this way, workings are prosecuted in the unresisting deposits of asbestos, where galleries without props are formed, the roof being kept up by pillars of the asbestos itself, left at intervals.

MEETINGS OF THE SOCIETY.

Foreign and Colonial Section.

Tuesday evenings at Eight o'clock:—

March 20.—"Social and Commercial Aspects of New Zealand." By William Delisle Hay. Sir Charles Clifford will preside.

Applied Chemistry and Physics Section.

Thursday evenings at Eight o'clock:—

March 22.—"Self-Purification of River Waters." By W. N. Hartley, F.R.S.E. Prof. Abel, C.B., F.R.S., will preside.

Cantor Lectures.

Monday evenings at Eight o'clock:—

Third Course, on "The Decorative Treatment of Metal in Architecture." By E. H. Birch, Assoc.Inst.B.A.

Lecture I.—April 2.

Introduction.—The employment of subsidiary arts in architecture. The decorative treatment of the precious metals in ancient architecture. Its occasional use in Egyptian, Assyrian, Babylonian, Mede, Persian, and Jewish architecture. Greece and Rome, the Christian Dispensation.

Bronze.—The Bronze age. Nature and qualities of bronze. Its earliest use. Nineveh, Babylon, Mycenæ, Pelasgic, and Etruscan. The classic period.

Lecture II.—April 9.

Bronze (continued).—Rome, Lombardy, Germany, Hildesheim, Italy, during the Middle Ages. The culminating point during the Renaissance.

Iron Work.—The Art of the Blacksmith, and the use of wrought iron in the north of Europe.

Lecture III.—April 16.

Iron Work (continued).—Germany—Augsburg and Nuremberg—15th and 16th centuries. England, 17th century.

Lead.—How used. Artistic treatment of the Middle Ages. Its capabilities.

Conclusion.—The use and abuse of metal work; modern bronze work; the decorative treatment of the metals, as applied in these days; our failures and successes.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 19...National Indian Association (at the House of the Society of Arts), 4 p.m. Annual Meeting.

Charity Organisation Society (at the House of the Society of Arts), 11 a.m. Conference on "Emigration."

Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Mr. F. Cheshire, "Bees, in Relation to Flowering Plants and Fruit Production."

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Dr. E. B. Tylor, "Original and Borrowed Civilisation."

Tuesday, March 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. W. Delisle Hay, "Social and Commercial Aspects of New Zealand."

Science Society, King's College, Strand, W.C., 8 p.m. Mr. E. S. Hasell, "Birds' Nests."

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on Mr. Ralph Hart Tweddell's paper, "The Productive Power and Efficiency of Machine Tools, and of other Labour-saving Appliances worked by Hydraulic Pressure;" and on Mr. Alexander McDonnell's paper, "Stamping and Welding under the Steam Hammer." 2. Mr. William Smith, "Summit-level Tunnel on the Bettws and Festiniog Railway."

Statistical Society (at the Theatre of the Royal School of Mines), 28, Jermyn-street, S.W., 7¾ p.m. Rev. James Johnston, "Education in India, and the India Commission on Education."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Professor Huxley, "The oviduct of *Osmerus*, with Remarks on the Relations of the Teleostian with the Ganoid Fishes." 2. Mr. G. A. Boulenger, "Description of a Species of new *Bufo* from Japan." 3. Mr. Sclater, "Remarks on the List of British Birds."

Wednesday, March 21...Meteorological, 25, Great George-street, S.W., 7 p.m. Dr. Henry Cook, "Notes on a March to the Hills of Beloochistan in North-West India, with Remarks on the Simoom, and on Dust Storms." 8 p.m. Opening of the Exhibition of Meteorological Instruments for Travellers, and of such new Instruments as have been invented and first constructed since the last Exhibition; and Address by the President, Mr. J. Laughton.

Geological, Burlington-house, W., 8 p.m. 1. Dr. Archibald Geikie, "The Supposed Pre-Cambrian Rocks of St. David's." 2. Prof. T. G. Bonney, "Additional Note on Boulders of Hornblende Picrite near the Western Coast of Anglesey."

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. E. Walford, "Ancient Stained Glass at Hampstead and Oxford connected with Bishop Butler." 2. Mr. E. P. Loftus Brock, "Antiquarian Discoveries at Westminster and in the Site of St. Leonard's Church, Eastcheap."

Thursday, March 22...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Mr. W. N. Hartley, "Self-Purification of River Waters."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Institute of Bankers, in the Theatre of the London Institution, Finsbury-circus, E.C., 6 p.m. Mr. John Smith, "Notes on the Government Bankruptcy Bill."

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. Ernest Pauer, "Beethoven's later Sonatas."

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Journal of the Society of Arts.

No. 1,583. Vol. XXXI.

FRIDAY, MARCH 23, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

COLLISIONS AT SEA.

The Council have appointed a Committee to consider the question of preventing collisions at sea. The work of the Committee will be confined to a consideration of the best means of preventing collisions in fogs. The Committee will be glad to receive any information on this subject from persons who have given their attention to it, or to consider any proposals having for their object the prevention of such collisions. All such communications should be addressed to the Secretary of the Society of Arts, John-street, Adelphi.

H. Trueman Wood,
Secretary.

Proceedings of the Society

FOREIGN AND COLONIAL SECTION.

Tuesday, March 20, 1883; Sir Charles Clifford in the chair.

The paper read was—

SOCIAL AND COMMERCIAL ASPECTS OF NEW ZEALAND.

By W. Delisle Hay.

Before I enter upon the conditions of life in New Zealand, as they exist to-day, it may be well to refer briefly to the past history of the colony. Not all of you are aware, perhaps, of the progress of events in our most distant possession, and a short sketch of the successive changes that have occurred there may help you to appreciate more clearly what belongs to the present. But my retrospect must necessarily be in outline only.

Between the date of first discovery, and the time when the country came into certain relations with our own, a long period elapsed. The year 1814 began a period that may be spoken of as the missionary epoch, and which lasted for twenty-five years. The condition of things in 1814 may be thus described. The interior of the country was wholly unknown to Europeans, the coasts had only been explored to a very limited extent. A few discovery ships, a few whalers, a few adventurous traders from Sydney, had, from time to time, established some fitful intercourse with the Maori, as the aboriginal inhabitants were called. Occasionally some Maori shipped as seamen on board vessels calling on their coasts, and were thus carried to Australia, or even to England.

By these means a little was known respecting the race of men inhabiting New Zealand. They were described as the most ferocious, ruthless, bloodthirsty savages on the face of the earth; treacherous, cunning, and fearless as tigers. Their tribes were continually at war with one another; they indulged in cannibalism to an extent previously undreamt of, the very remembrance of which is now awful to contemplate. They had not hesitated to attack the white man, despite his firearms, which, moreover, they were eager to possess. They had sometimes captured, massacred, and eaten whole boats' crews, even entire ships' companies. But little was then known of the Maori that was favourable to them. They were of splendid physique, and their intelligence was of a far higher order than that of the Australian blacks, or than that of most of the negro tribes in South and Western Africa with which we were then acquainted. Their sagacity was evidently great, and they were credited with a singular love of justice, subservient to their own laws and usages.

These facts aroused a strong interest in the Maori among a few English people. Foremost of these was Samuel Marsden, chaplain to the Governor of New South Wales, and thenceforth to be known as the "Apostle of New Zealand." Towards the end of 1814, this clergyman, with several missionary companions, sailed from Sydney, and landed in the Bay of Islands, where they celebrated the first Christian service in a Maori kainga on

Christmas-day of that year, before an immense concourse of the Ngapuhi tribe. This event initiated the missionary epoch in New Zealand.

For some years after the advent of Marsden, little progress was made. Sydney traders became more frequent along the coasts, exchanging firearms for timber, pigs, and phormium fibre, supplied by the Maori. Frightful carnage among the tribes followed the introduction of the new weapons. But as we near the end of the missionary epoch, as we approach the year 1840, a manifest change becomes perceptible. The social aspects of the country had altered for the better.

The missionaries had found the Maori possessed of a certain rude barbaric semi-civilisation of their own. They had their tribal organisations, their feudal system, their princes, lords, warriors, commoners, and slaves. They had an intricate code of laws, comprised under the name of the "tapu," with which was bound up some religious symbolism. They had a legendary history and genealogy, which provided poets and orators among them with a store of material for speeches, songs, and proverbs. They tilled the ground, and cultivated several vegetables as a main source of food. They wove dresses out of phormium fibre, and made implements, instruments, and weapons out of stone, shell, and wood, suitable for various purposes, and of excellent finish. They constructed canoes that could live in a stormy sea, and some of which were large enough to contain more than a hundred persons. They built houses of a kind of thatch or wicker-work, which were durable, commodious, and often elegant. These houses were collected into kainga, or villages. Then they had their pa, or castles; fortifications that were designed with no little engineering skill, defended by earthworks, ditches, and palisades.

Nor must I forget to mention to you that the ancient Maori had their Society of Arts. They carved in stone and wood with wonderful symmetry, decorating canoes, houses, and their own persons with various adornments of this kind, grotesque and curious in design, but executed with surprising care and finish, when we remember that metal tools were unknown to them. But the most prominent and important member of that society I referred to just now was not he who carved in senseless wood and stone, but he who drew his designs upon living human flesh. This was the artist who produced the "moku," or tattooing. He was something of a surgeon, something learned in heraldry, too, as well as mere manipulator. He traced the patterns with which the high-born chiefs and noble warriors were emblazoned on faces, chests, and thighs; patterns intricate, awe-inspiring, beautiful—in Maori eyes—but more than that, denoting the rank and doughty deeds of him who bore them. The artist on skin was of much consequence if skilled in his profession. Tribes went to war to secure his residence among them. All honour was his so long as he lived; gorgeous obsequies followed on his decease; and long after his death his name was famous in song and story.

There was, then, much that was amiable and pleasing in Maori character, both individual and social; yet the race lived only for war, incessant and implacable, tribe against tribe; and the end and consequence of war, the reward and triumph of the conqueror, was cannibalism—man-eating in its most atrocious and appalling forms.

Such were the people to whom Marsden and his missionaries came, bearing in one hand the Bible, in the other implements of agriculture and peaceful industry. Hostile as the Maori had often shown themselves to the white man, they no sooner understood the objects of the missionaries than they welcomed them; for their keen sagacity made them extremely anxious to learn what the white man had it in his power to teach them. Warlike propensities could not be overcome at once—old habit was too strong. Not in that generation was peace established: but it came at last.

Let us now look at the condition of things in 1839, the last year of the purely missionary epoch, for 1840 was to see inaugurated the era of colonisation.

Much more was now known in Europe respecting New Zealand. The great extent of country, the comparative scantiness of the native population, the vast resources of the land, the rich plains of the South Island, the wealth of splendid forests, the rivers, lakes, and harbours, the mountains and glens, the Alpine glaciers, volcanoes, and the wondrous boiling fountains, the rare fertility of the soil, the glorious climate and magnificent scenery; and the labours of many missionaries had borne marvellous fruit among the Maori.

Intertribal conflicts were now almost ended; cannibalism was wholly a thing of the past. Everywhere the "tapu Pakeha"—Christianity, and the rules of life arising out of it—had superseded or become blended with the ancient "tapu Maori." The mission stations were English villages, replete with every comfort;

and from them, as centres, civilisation and instruction spread around among the natives. The Maori tongue had been reduced to writing, and with exceeding aptitude the Maori were learning so to use it. Thousands of Bibles and other translations were distributed among them, and were read in the remotest kainga.

Not alone in morals was the change perceptible. Industrial arts had also made progress, particularly among those tribes, of course, amid whom the missionaries had longest lived and taught. The Maori farms had increased their products; the plough and spade were used. Wheat and maize, potatoes and peaches, and a hundred other importations were seen in the cultivations; cattle, sheep, and horses had been introduced, and were reared as well as pigs.

The Maori understood the value of commerce, and eagerly welcomed trading vessels from Sydney. They bartered with them no longer entirely for guns and powder; they required axes, spades, clothes, and sundry useful articles. Government was now more orderly. Vested in the hereditary chiefs, these were counselled and controlled by the missionaries, or were under the influence of their teaching.

I shall pass over the causes that led to the assumption of British authority, for a consideration of them would lead us into the region of politics. It is sufficient to say that it was delayed as long as possible, needlessly long, in fact. Sentiment desired the absence of Europeans from the country, the development of a free Maori nation. Utility saw a great fertile land, larger than all Great Britain, calling for an occupier; for most of New Zealand was a wilderness. The total Maori population was less than that of a single small English county. Circumstances eventually forced on a reluctant Government the annexation of New Zealand. They were, in brief, the disorders arising from the presence in the country of numerous runaway sailors, and other white men of bad character; the formation, in England, of a private company, whose intent was colonisation on its own account; the knowledge that France would annex the islands if we did not; and the representations of Marsden, Sir George Gipps, and other persons of influence.

On the 29th of January, 1840, H.M.S. *Herald* arrived at Kororareka, in the Bay of Islands. She had on board Captain Hobson, appointed Lieutenant-Governor of New Zealand, which had been newly proclaimed as having been placed under the government of New South Wales. On the 5th of February, at Waitangi, was signed the treaty by which the chiefs of the Maori tribes surrendered sovereignty to the British Crown. It was a treaty not extorted from, but offered spontaneously by the chiefs. The Treaty of Waitangi was signed by all the leading chiefs throughout the country, and constitutes the deed upon which our possession of New Zealand is based. From the date of its signature, a new era begins. We have done with the missionary epoch, the next is that of the pioneer-colonist.

Kororareka was the capital but a few weeks. The new government was soon shifted from the Bay of Islands, to the Waitemata Harbour, 130 miles further south, and a settlement was formed there, which has now become the large and important city of Auckland. Other settlements were soon formed on various harbours of both islands, which have since developed into great centres of the new population.

In the early days of British Government there was much squabbling about the land. It was proclaimed that all titles must proceed from the Crown, before legal transfers could be made. Courts were, therefore, appointed to adjust the land claims of the native tribes, as also those of persons to whom they had disposed of territory. This led to many bitter quarrels between colonists, missionaries, and Maori, as also between the Government and the New Zealand Company. It led, among other causes, to wars between the British and certain Maori tribes.

There were several of these wars between 1844 and 1869. In one or two instances they rose to the dignity of campaigns, in others they were guerilla conflicts. None of them were waged with the Maori as a whole people. All were fought with different tribal sections. Indeed, we had always native allies to fight on our side against their rebel compatriots. In 1844, when native troubles began, there were only about 13,000 Europeans in the country. In 1870, since which date there has been peace, there were over a quarter of a million of settlers.

But I do not intend to detain you with any accounts of Maori wars. They belong altogether to the past; they were strictly local; and though they affected the colony as a whole indirectly, yet they had but slight influence on its general progress. Some allusion, however, must be made with respect to what is called the "king movement," and to events which occurred in 1881 and 1882.

In 1860, certain of the tribes, living between the Waikato river and Taranaki, joined together under the chief Potatau, whom they styled "king." They threw off all allegiance to the British crown, and professed themselves to be an independent Maori nation. This was at the beginning of what is known as the Waikato war. By 1863, the insurrection had been crushed, the rebel strongholds had been taken, their territories along the Waikato seized and confiscated, and Potatau was dead. The Kingite Maori, as these people were called, then retired, under the leadership of Tawhiao, their new "king," within certain prescribed limits, known as the Kingite Pale. Here they dwelt in sullen isolation for some years, their policy being a "masterly inactivity." By degrees, however, they relaxed a little, came down to the settlements, opened intercourse with the Pakeha (Europeans), and soon took to trade. Recently, they have become quite friendly; Tawhiao and his sub-chiefs have been to Auckland and elsewhere; have agreed to sell lands, and to allow of the formation of roads and railways within the Pale. So the isolation and hostility of this little handful of Maori is now at an end altogether.

While this small section of the Maori were trying to constitute themselves into an independent kingdom, another movement was on foot among the interior tribes. This was the strange religious perversion known as Paimarire, or more commonly to settlers by the cant name of "Hau-hau," which was an attempt to form a kind of national church. Individuals from many tribes joined in it, and formed a sort of Salvation Army, under the leadership, eventually, of a "prophet," named Te Whiti. At first confounded with the "king movement," the two afterwards became more and more divided. The Zion of the Hau-hau fanatics was a kainga called Parihaka, on the borders of Taranaki and Patea. Not only a Zion, it was also an Alsatia, where the Queen's writs could not run, where the disaffected gathered, and where thieves and murderers took refuge.

In 1879, and later, settlement drew near and nearer to this stronghold. Lands that had been confiscated after the war, years before, were now taken up. To these proceedings the Hau-hau objected, and began to molest the settlers, and ravage their new homesteads. Things got so warm, and bloodshed seemed so imminent, that the matter came before Parliament. In 1881, a body of volunteers and constabulary were sent into the district. They surrounded Parihaka, and, without any bloodshed or fighting, arrested Te Whiti and his principal adherents, who were sent to Wellington for trial. Parihaka was broken up, and its inhabitants were either dispersed to their tribes, or were deported to reserves elsewhere. Meanwhile, the kingites further to the north were perfectly quiescent. Indeed, the "king" Tawhiao and his principal followers were being entertained and banqueted in the city of Auckland. These events constitute, no doubt, the last and closing scene in the history of Maori troubles.

I said just now that the missionary epoch was succeeded by the pioneer-colonist epoch. This began with the signing of the Treaty of Waitangi, and ended with the year 1852. It was truly a pioneering time, for, during those years, the first essentials of life had to be provided. Emigrants in those days had to step from the ships that brought them, on to shores that were a primeval wilderness. They had to build houses, and make enclosures, to plan the sites of future towns, and to form settlements; and they did not set to work with a town within sight of them, as now, but 1,200 miles from the nearest centre of civilisation—Sydney, in Australia. One may readily suppose that the time was a rude and rough one indeed. Then the Government had to be formed, at first by Captain Hobson, next by Captain Fitzroy, then by Captain (afterwards Sir George) Grey. The land tenure had to be fixed on a firm basis, and the various difficulties with regard to it met and surmounted, before the settler could begin to clear, and fence, and plant. There was fighting to be done, too, for during this period was waged the war in the north, and the wars in Wellington and Wanganui.

But when 1852 came, the young colony was ready for representative government. There were now 30,000 English people in the country; Auckland and Wellington were already towns; the new settlers were at work with boundless energy; farming industry was progressing in one locality and another. Peace and plenty, enterprise and activity, reigned everywhere. Already there was a revenue; already New Zealand was exporting some of her produce.

In 1852, the New Zealand Constitution Act was passed by the Imperial Parliament, and was proclaimed in the colony in January of the following year. From this date, therefore, a third epoch begins, the era of provincial government. This lasted until the year

1877, which was to witness another new departure.

The Constitution Act created a Colonial Parliament, composed of two Chambers—the Legislative Council, whose members are nominated by the Governor, and the House of Representatives, which is elective. Maori can exercise the franchise, if properly qualified, in common with settlers. They also return four members of their own race, to guard special Maori interests in the House. There are likewise Maori in the Legislative Council. The House was elected for five years (now for three), and the functions of the Chambers are similar to those of the British Parliament. The power of the Governor is limited, like that of the Queen, and is exercised by responsible ministers, who, in their turn, represent the voice of a majority of the people.

By the Constitution Act, New Zealand was divided into six provinces—Auckland, Wellington, and Taranaki; Nelson, Canterbury, and Otago; three in each island. Subsequently it became necessary to partition certain of these, as settlement increased. Hawke's Bay became a separate province in the North Island; Marlborough and Westland in the South. Each province elected its own Superintendent and Provincial Assembly. These local legislatures had considerable powers within their several limits, over finances, land, public works, and divers other matters: thus, during the provincial epoch, New Zealand was a remarkably well-governed country. In fact, there were some who said it was too much governed. In the early days, it was said, every second man you met was either a representative or an official.

During the twenty-five years of the provincial epoch vast progress was made, some of the results of which I am going to speak of presently. Immigration was induced by every possible means, for what the country most needed was population. It possessed already everything that might render an industrious people prosperous and happy. And, in spite of the distance from England, in spite of exaggerated accounts of Maori difficulties, in spite of the rival attractions of Canada and the Australian Colonies, New Zealand drew, and continues to entice, a considerable annual contingent of emigrants from home.

During this period, too, many of the resources of the country underwent development. Pastoral and agricultural industries became each year more extensive, proving the fatness of the land, and indicating the opulent future in store for it. And its mineral wealth was discovered, and began to be worked. Coal, iron, copper, building-stone, and pottery-clay offered themselves in boundless abundance. But gold transcended these in the inducements it presented to the miner. Gold exists in many parts of both islands; literally, as well as metaphorically, the soil of New Zealand is a golden one. Numerous gold-fields have been opened; in Coromandel and the Thames district, in Auckland; at Blind Bay, in Nelson; at Hokitika and elsewhere, in Westland; at Wakamarina, in Marlborough; in Tuapeka, the Clutha Valley, the Lake District, and elsewhere, in Otago. It is washed from the soil of valleys, it is dredged from the beds of rivers, it is mined from the mountain quartz. Gold has done much for the colony. It has caused a great influx of population, has given employment to many, and has enriched some. It has given a huge incentive to all other industrial enterprise. To the gold discovery the great city of Dunedin owes its rise to present importance. Gold-seeking has brought into existence Hokitika, the Thames boroughs, and other towns, as substantial monuments of the service it has rendered in the colonisation of the country.

But, in the year 1876, came an important change, and the commencement of a new era of New Zealand history. The cause of this was the abolition of the provinces. It involved no less than a reform of the constitution. Government was re-modelled and entirely centralised. The provincial legislatures were swept away. Their separate finances and land Acts were brought into unity. The franchise was reformed and extended. Parliaments became triennial. The seat of Government had been removed from Auckland, in 1865, to Wellington, which is more centrally situated. Wellington, therefore, now became the metropolis of the whole country, in a more complete sense than formerly.

The old provinces of New Zealand, then, exist no longer. Their names linger awhile, as geographical expressions, but even these are destined to disappear, and are already passing into disuse among New Zealanders. The new political division of the country is into sixty-three counties, each of which is sub-divided into ridings and road districts. These are provided with administrative and electoral machinery suitable to their needs. In sixty-nine borough-towns there are municipal boards, or mayors and corporations,

much the same as you are accustomed to here.

The Abolition Act and the subsidiary Acts of 1876, were not passed by Parliament without a struggle. Both within and without the House a fierce conflict was waged. Agitation was resorted to throughout the country, and I have a lively recollection of the ferment that ensued. Various vested interests were interfered with by the change, while the relative financial position of the different provinces was so unequal as to present many and great difficulties in the way of centralisation. Politicians stormed and clamoured, and, at one time, it seemed likely that the North and South Islands would separate altogether. Indeed, to listen to the arguments used on either side, one would have thought that civil war between North and South might become a possible feature in the programme. However, the Ministry carried their measures, and thus relieved the country of a weight that had long oppressed it, while providing a more useful system for the future.

Having now put before you an outline of New Zealand history, I shall attempt to tell you something of the conditions of life there at the present time, and of the institutions of the colony.

The native element is a small one nowadays, and is a feature demanding much less consideration than was once the case. The total Maori population is no more than 44,000, scattered in various little communities in different parts of the country. The bulk of them are in the North Island, there being some 2,000 only in the South Island, and about 200 in the Chatham Islands. Against this, you have to consider an English population more than ten times as numerous. By the census of 1881, there were 489,933 Europeans, and about 5,000 Chinese. As the English population is increasing very rapidly, both by the birth-rate and immigration, and the Maori population is stationary —if not, indeed, lessening slowly—it is evident that the latter becomes annually of decreased relative importance. I shall not, therefore, take up your time with much more reference to the aboriginal race.

To give you an idea of the rapid increase of English population in New Zealand, I will just mention one instance in point. The subject is of great interest, for, during the last decade or two, the increase in New Zealand has been proceeding at a more rapid rate than anywhere else. The figures I quoted just now are from the tables of the census taken on April 1st, 1881. But an estimate was made on December 31st of the same year, showing a further increase of nearly 11,000. Of this, only about 600 could be set down to immigration, since departures from the country had nearly counterbalanced the new arrivals. The bulk of the number was due to births in excess of deaths. In December, 1881, therefore, there was an English population of 500,910. By the present date, that number has probably become augmented by 15,000 or so.

Authorities are not altogether agreed as to the causes which are bringing about this rapid multiplication. No doubt the climate and temperature are peculiarly well suited to our race. Healthful conditions of life, abundance of wholesome food, absence of vice and pauperism, are all important factors. And it was recently pointed out—by Mr. Giffen, I think—that the constant recruiting of the population by young adult immigrants of both sexes, was a fruitful reason for a high birth-rate.

It is a singular fact that the land which is witnessing the most abundant increase of our own race, should also manifest a very perceptible decline in the native Maori people. Forty years ago, their numbers are presumed to have been double what they now are. Their decline has not been due to war, to want, or to drink—at any rate of late years. It has been due to disease, scrofula and others, particularly affecting the women. Yet now, as their recourse to civilised habits of life becomes year by year more extended, as medical skill operates for their benefit, some check has been given to their decay. Decrease is still proceeding, but has, apparently, become retarded. Indeed, among one or two of the most civilised tribes, the Ngatiwhatua for instance, there has even been a slight increase. The coming extinction of the Maori, then, is not so certain, or so speedily to be expected, as has been hitherto supposed.

To attain anything like an accurate conception of New Zealand, it is needful to consider it in detail, and to avoid erroneous general notions. Between the North Cape and South Point—1,000 miles distant from each other—there are widely different characteristics to be noted. Differences of climate, of productions, of natural features; differences in population, in the character, progress, and occupations of the people. In these respects, and more, we may compare New Zealand, for a moment, with Great Britain. In the latter there is not

more width of variance between Warwickshire and Caithness, Kent and Cumberland, than there is in the former between Mongonui and Clutha counties, or between northern and southern, eastern and western districts.

Then we must consider the population under two aspects, urban and rural. About 200,000 people are strictly townsfolk; 300,000 dwell in the country. These, again, may be regarded in different lights; the inhabitants of the principal cities and of lesser towns, of old towns and new towns, of seaports and inland towns, manufacturing and mining towns, borough towns and mere incipient townships. The rural population also presents itself under varying aspects, which give their special tone to individual counties. The shepherds and stockmen of the great grass plains and mountain slopes; the corn-raising cultivators of the rich alluvial valleys; the sawyers and bush farmers of the forest regions; the gold miners, colliers, and gum diggers; those engaged in furthering traffic by land and water. All these classes present many contrasts and comparative differences.

There are, in the sixty-three counties of New Zealand, some hundreds of townships. But the greater number of these places are in a very incipient stage, as you may well suppose. Hardly could some of them rank as hamlets or villages, in the estimation of people accustomed to the thickly populated countries of Europe. They are more like that famous "city of Eden," which you remember Dickens pictured in "Martin Chuzzlewit."

But there are more than 150 towns having a population exceeding 100. Of these, some forty would deserve the name of town even in England, having more than a thousand inhabitants in the smallest of them. About a score are places of some consequence, a few of them being dignified by the title of city. I shall speak separately of some of them, together with the counties in which they are situated.

Perhaps I cannot find a better way of illustrating to you the advancement of New Zealand towns, the business done in them, and the increase of population, than by a word or two respecting the "fourth estate," as represented in the colony. The issue of a newspaper, especially where the cost of its production is greater than in England, argues the presence of a sufficient number of advertisers and readers locally to render it a successful undertaking financially. There are now published in the colony about 200 periodicals, over 50 of which are daily papers, morning or evening; 90 or so published once, twice, or thrice a week, and the rest fortnightly, monthly, or quarterly. They are issued by various presses in some 70 different towns, whence they circulate through the neighbouring settled districts. A few are illustrated, two or three are exclusively Maori, and a good many are large and excellent, both in the matter they contain, and in the style in which they are issued. I think that the press of New Zealand demonstrates in itself the life and stir, the energetic industry of the country, and abundantly testifies to the development and progress that have accrued to these far-away islands from 40 years of British colonisation. For, when you have your newspaper with the morning roll, and your "special evening edition" when the work of the day is over, it is easy to understand that around you are all the other comforts and refinements which go to make up advanced modern civilisation.

Wellington, as being the capital, is the city I shall first of all refer to in particular. In point of size, Wellington is smaller than either Dunedin, Christchurch, or Auckland, having a population of 21,000. It is situated on Port Nicholson, which opens out of Cook Strait, and is in Hutt County. Within the municipal boundaries are thirty-seven miles of streets—some of them rather open as yet, though. However, there are fine streets, well laid out, with buildings and shops on them of considerable architectural pretensions. Government House, the Houses of Parliament, and the Government offices are naturally objects of great interest. The Colonial Museum is an institution meriting exceptional reference. Here a little band of scientists hold sway, studying the natural features and resources of the country, pointing out the way for their practical development, and, generally, leading the intelligence of New Zealand. There is a cathedral, and there are fourteen churches and some chapels, belonging to various denominations. Some of the banks, of which there are six, I think, are handsome edifices. There are, among other noteworthy institutions, two large theatres, public halls, a number of fine hotels, a college, and sundry schools, a capital hospital, and a lunatic asylum. The industries are not so well represented as in the other cities. There are two foundries, eleven boot factories, candle and soap works, a tannery, three fruit-preserving establishments, flour, coffee, and biscuit mills. There are waterworks, gas-works, tramways, public gardens,

and plenty other evidences of comfortable city life.

Society in Wellington, as in other colonial cities and towns, is not divided by the sharp grades we recognise here. It is tolerably catholic in its extent. As I need scarcely say, the leading feature in Wellington society is officialism. Government is the main industry of the place; government secular, government ecclesiastical, government educational, government philosophical. This brings together a larger number of cultivated intellects, perhaps, than are usually met with elsewhere in the colony. There is the commercial tone of Dunedin, the polite tone of Christchurch, the ecclesiastical tone of Auckland, but in Wellington the tone political is supereminent. You have—especially when the House is in session—the sound of politics ever in your ears. One theme of conversation prevails in all social gatherings, in the street, in the theatre, at the dinner-table, at the club, and in the ball-room. For, little as you may think of colonial politics at this distance, they yet give rise to party-spirit as fierce, violent, and absorbing as any disputant could wish for.

But, to touch on another topic. The harbour of Wellington is a very spacious one, and is said to be the safest and most commodious in all New Zealand. That, however, I may remark, is likewise said of several other harbours, by those who reside about them. Still, this port is undeniably destined to be the scene of extensive commerce. Its central position, and its accessibility from both east and west, have already given to it much importance, and will bring it much more yet. Then it is the port for a large extent of rich country, which is already being well taken up.

A railway runs northward from Wellington, through the county of Hutt, and thence into that of Wairarapa West. It stretches up the Wairarapa Valley, a rich fertile tract, which may be compared, perhaps, with the Severn valley in England. The town of Featherston is reached first, forty-four miles from Wellington, having 800 inhabitants. Nine miles further on is Greytown, having a population of 1,500, with churches, banks, factories, schools, newspaper, and so on. Thirteen miles separates this place from Carterton, a town of 1,300 population, also a thriving place. About the same distance, and Masterton is reached, the present termination of the line. Masterton is the most important town in the valley, having a population of 2,500; it lies seventy-one miles distant from Wellington, in a straight line. There are some excellent public buildings in the place, and it is well laid out. A suburb of Masterton is situated amid picturesque scenery, and contains a number of handsome villas.

These towns are the centres of the county, Wairarapa West, which has, altogether, a population between 9,000 and 10,000. The county is well timbered in some parts, in others open and pastoral, and a good deal of it is now being got under crop. The sheep and cattle runs are pretty extensive, but the agricultural holdings are mostly small ones.

Beyond Masterton, there is a good deal of scattered settlement. The Scandinavian town of Mauriceville, fifteen miles from Masterton, is another centre. From Masterton good roads extend in several directions. Coaches are regularly run along them, until such time as the railway shall supersede them. To the north-east lies Makatoto, a small township about fifty miles by coach from Masterton, the intervening country being rather rough. Makatoto is not of importance, except that it is just now the terminus of the railway from Napier, seventy miles further on, and 200 miles from Wellington. The railway will soon extend from Masterton to Makatoto, and there will then be through communication between Wellington and Napier.

Napier, as, doubtless, you remember, was the capital of Hawke's Bay province, while that existed; it is now the chief town of Hawke's Bay county, which comprehends one-third the area of the old province. It is, comparatively speaking, a quiet place, but capital is well represented here. The harbour is a fair one, though not first-class, and has been improved by costly works. The population is 5,756. There are in the place some fine buildings and institutions, as well as many villas around it, evidencing wealth and prosperity. The principal industry of the county is wool-growing and cattle-raising, the lands being mostly suited for grazing. But here, and in Waipawa and Wairarapa East, counties lying south of Hawke's Bay, more attention is now being paid to agriculture, and to the cultivation of cereals. There are tracts of forest country in these districts, but, besides the railway, good roads traverse and intersect them. Artistic and intellectual societies and institutions flourish with especial vigour in Napier.

Eighty miles north-east of Napier is the town and port of Gisborne, situated in Cook county, which lies around Poverty Bay, and up

to the East Cape. This district has been rather isolated hitherto, being nearly 300 miles distant by sea from either Auckland or Wellington. Gisborne is, however, a thriving little town of somewhat less than 2,000 inhabitants. It has some good buildings — churches, theatres, banks, hotels, and stores—and has its two daily papers. There is a rich pastoral and agricultural country around Gisborne, but sparsely taken up. Recently, some impulse was given to the place by the discovery of mineral oil at Waipaoa and Waiapu, which may prove a source of great wealth by-and-by. To the north-west of Gisborne lies an immense region of rugged mountain and forest, in part peopled by scattered communities of Maori. This is the famous Urewera country, where the brigand Te Kooti and his band took refuge in bygone years, and whence they were with difficulty ejected.

We must now return to Masterton, and proceed thence in a westerly direction. A good coach-road extends to the north through a rich forest country, then across the Tararua Mountains by way of a pass called the Manawatu Gorge, and down from thence to the town of Palmerston, distant some fifty miles from Masterton. Palmerston stands in a forest clearing. It has a population of 1,366, and, though very young, is a fine well-laid out town, showing abundant evidences of prosperity. Its industry is principally connected with timber, there being in it large saw-mills, door and window-sash factories, and so on. But agriculture follows as the forest disappears before the axe. In Manawatu and Rangitikei counties there is much rich land yet to be taken up.

Palmerston is a station on the Patea-Manawatu Railway, which extends from Patea and Wanganui, in the north-west, to Palmerston, and thence twenty-four miles to Foxton, a temperance settlement, and the port of the Manawatu river. The railway is being pushed on as fast as possible, and will soon be connected with the line now terminating at Masterton, and again with that from Napier, now ending at Makatoto. For the present these gaps are filled up with coach-roads. To the north, the railway reaches to Patea, or at least to Waverley, a few miles short of the former town. It will be continued to Normanby, where it will join the line already laid down the back of Taranaki from New Plymouth. Eventually, the line will connect New Plymouth with the Waikato Railway from Auckland, and so the settled districts, cities, and towns will have ready intercommunication. Five years ago this railway system was only just commenced. Ten years hence will probably see the trunk line completed, and branches, as yet not even projected, also laid down. The value of roads and railways in developing a country can scarcely be appreciated to its full extent, perhaps, except by those who have had to encounter the difficulties attendant on the want of them.

From Palmerston to Wanganui by rail is a distance of 62 miles. The line traverses a good country, crosses several rivers, and passes a number of embryo towns that I have not time to notice. Wanganui is a large place, as towns go at the Antipodes, having 4,646 inhabitants. It is situated four miles above the mouth of the river, which is not navigable for large craft, having a bar, and being rather shallow. Wanganui was first settled soon after Wellington, from which place it is distant 100 miles by sea. It was at one time the scene of conflicts with the Maori. Now there is a Maori college here, built and endowed for the higher education of the sons of our former foes. Wanganui is well built, having many fine edifices, institutions, and shops; it has its theatre, public library, hospital, collegiate and high schools; there is a remarkably fine iron bridge, 600 feet long, across the Wanganui river. The counties of Wanganui and Patea contain extensive plains of very rich soil; much behind is yet unoccupied, but I hear that settlers are now going inland a good deal. Agriculture here is only beginning as yet; but the exports from Wanganui of cattle, sheep, wool, and dairy produce have been very considerable. There are workshops here for the production of railway material.

Thirty-three miles further on, after passing through several villages, the railway ends at present, but will soon be completed over the eight or ten miles now separating it from Patea. This last is a pretty little town of 800 or so. But there are harbour-works going on here, and when they are complete, the railway connected, and the country more settled, Patea will probably rival, and possibly excel Wanganui. From Patea on to Hawera—a town of 943 inhabitants—and Normanby is about twenty-five miles by coach, and then we pick up the railway again, forty-eight miles north to New Plymouth, passing behind the snow-capped, volcanic peak of Mount Egmont.

Probably you are all familiar with the names of Taranaki and New Plymouth, and very

likely you are equally unfamiliar with the names of most of the other towns I have noticed in the journey north and west from Wellington. Nevertheless, New Plymouth is neither so large nor so important a town as Wanganui, and probably both Hawera, Patea, Wanganui, and other settlements to the south will attain more eminence than New Plymouth ever will. Yet, when the railway line to Wellington is complete, and, more especially when the Auckland and Waikato line has been continued here, there is no doubt that New Plymouth will greatly develop itself.

New Plymouth was founded in 1841, by a special and selected body of emigrants from Cornwall, Devon, Dorset, and Hampshire. But it has not made much headway hitherto, partly because of its isolation, partly from want of means to develop its resources, and partly from the serious hostility it has had to encounter from neighbouring tribes of Maori. It has now a population of 3,310, but neither its public buildings nor its institutions evidence such progress as in many other New Zealand towns. The climate and soil are both favourable to agriculture, however. Society here manifests a very decided similarity to that of some quiet town in the south-west of England.

Operations connected with phormium—the native flax—rope-making, canvas and sack-making, appear well suited to the district; and the growth of beet for sugar-making is advocated as being peculiarly well adapted to Taranaki soil and climate. But both these industries are things to come. The chief resource of Taranaki, however, undoubtedly lies in the titaniferous iron-sand which exists there, and which yields a remarkably fine quality of metal. The ore abounds in inexhaustible quantity on Mount Egmont, in every creek flowing from it, and for miles along the beach. Difficulties in smelting it seemed to discourage its utilisation. But a method has been found for surmounting them by the use of charcoal. Another industry is thus promoted, charcoal-burning in the immense forests further inland. In 1879, excellent steel cutlery, railway plant, and so on, were made experimentally from this ore. The results show that, were a little more energy and capital infused into the district, Taranaki might become an Antipodean Cleveland, and New Plymouth cutlers rival those of Sheffield.

I shall now pass to the city of Auckland, which in size and commerce has only one rival in the colony, Dunedin, 800 miles to the south. With its suburbs, Parnell, Onehunga, and others of lesser importance, really conjoined to it, Auckland has a population of about 40,000. It is picturesque, healthy, well built, and well provided with public institutions, too numerous for me to detail just now. Auckland is the seat of much manufacturing and industrial enterprise, employing thus a large number of hands. There are glass works, shipbuilding yards, boiler works, boot and clothing factories, foundries, machine and implement works, printing-houses, tanneries, rope and sail factories, and various smaller establishments. There are an opera-house, theatre, and several public halls; an institute, extensive library, and museum; a botanical garden, domain, and public parks; hospitals, asylums, and refuges; university colleges, grammar schools, high schools, &c.

And here let me say a word or two having general reference. The educational system of New Zealand is very good, is under State control and endowment, is exceptionally thorough, and is wholly secular, free, and compulsory. The standard of the primary schools is high, and secondary schools supply admirable instruction for both sexes, as also for the Maori in particular. Then there are normal schools, training institutions, and religious preceptories of different kinds. There is the New Zealand University, and the University of Otago. Both are chartered to grant degrees, and are presided over by distinguished professors. The latter has fine buildings in Dunedin, and is well endowed with land.

As regards defence and the maintenance of order, the colony is policed by a body of armed constabulary, comprising some 1,500 officers and men. There is a volunteer force, cavalry, infantry, and artillery, of about 10,000 in all. Provision is also made for marine defence, by harbour batteries, torpedo boats, and so on. Cadets are trained, and military drill is a compulsory branch of education.

New Zealand is a very religious country, and, having regard to the scantiness of population, may be said to bristle with the spires of churches and chapels. Episcopalian, Presbyterian, Wesleyan, Catholic, Baptist, Independent, and Quaker bodies preponderate, and are well provided with all kinds of institutions. I have remarked that denominational differences not infrequently take the place of class distinctions in colonial society. Auckland presents this a good deal, and I think there is in society there a stronger infusion of polemical religious tone than else-

where. But, perhaps, I am mistaken. Of course, I do not intend by this to institute any comparisons as to relative piety.

You will see by the map that Auckland stands upon an isthmus, six miles in width at its narrowest point. It has thus a port on either side of the land. Auckland proper, on the Waitemata, is joined by rail to its suburb Onehunga, the western port on the Manukau. This is a large place, where there is considerable industrial activity. Practically, it is a part of Auckland. Both harbours are good, and the ports furnished with piers, wharves, docks, and so on. The port of Auckland owns 216 sailing vessels and fifty steamers, mostly, however, of no great size. But a large commerce is carried on with English, American, and Australian ports, which send many ships and steamers here annually.

The country lying to the north of Auckland I have described in detail elsewhere. The railway from Auckland goes as far as Helensville, on the Kaipara River. This is a little town of 326 inhabitants, carrying on the businesses of fish-canning, soap-making, and saw-milling. The Kaipara Harbour, with its numerous estuaries and affluents, opens up a large extent of country, most of it forest land, some of very good quality, but little taken up by settlers. The Wairoa River, which flows from the north, is navigable eighty miles up for ships of heavy tonnage. It passes through magnificent kauri forest, and there are growing towns, Dargaville, and Aratapu, on it, whose population are mostly employed at large saw-mills, though now some farming is also carried on upon the cleared land. Beyond Helensville, all traffic and transit mostly depend on the water communications, the roads being mere bridle-tracks for the most part.

Mahurangi, on the east coast, is a little town of 146 population. Its operations are farming, and the production of hydraulic lime, bricks, and building-stone. With these resources, and with the presence of excellent pottery clays in the neighbourhood, the settlements here will probably develop largely. Near by is Waiwera, a hot-spring and sanatorium for Auckland, having now large hotel accommodation. Opposite Mahurangi is the little island of Kawau, Sir George Grey's home. Here he has a residence which is a museum in itself, and he has made the island the home of numerous botanical and zoological importations. Excursionists are allowed to visit it frequently.

On the rivers flowing into Whangarei Harbour, eighty miles north of Auckland, there are several little townships. Canadians settled here a good deal. Whangarei town is a thriving, pretty, and well-built place, with 500 population. It has three churches, two schools, literary institute, public library, banks, hotels, &c. Coal is worked in the district. The settlements round the Bay of Islands are quiet villages, mostly peopled by descendants of the early missionaries. Kororareka, still a small place of 300 inhabitants or so, is a port of entry for whalers. Kawa-Kawa is the most noticeable place in the Bay. There is here a large colliery, exporting much coal, cement, and manganese. The population is about 500, and there are ten miles of railway from the mine to the river mouth. Northward of the Bay settlement is very scattered and small. Farming is carried on, but it is hardly so progressive as it might be. Rich volcanic soils exist here that have yet to be properly utilised. But energy seems lacking in this part of the country. Round Waimate, Ohaeawae, and Okaehau is principally centred the Ngapuhi tribe, the most civilised of the Maori tribes. They muster about 5,000. Many of them are well-to-do farmers, living and working quite in English fashion, having adopted all the manners, customs, and institutions of our civilisation.

While speaking of the north, I must not forget to mention the kauri pine. This mammoth tree, to which we have nothing here to compare, unless it be a factory chimney, grows in great forests here and there throughout the north, and as far down as about the 38th parallel of latitude, but no further south. Its timber is very valuable, and many saw-mills are cutting it exclusively. An immense quantity of kauri timber is used up in the colony, and is exported elsewhere. There are many other fine timbers cut in the country, but this is decidedly the best for general purposes. Then there is kauri-gum, which forms a large and valuable export to the United States, where it is used for varnish-making. This is a resin, not unlike amber, but less tenacious. It is dug from the ground in many places, the sites of ancient and extinct kauri forests. Maori dig a good deal, but so also do a class of Englishmen, known as gum-diggers. These wander about the wild country in twos and threes, digging gum wherever they find it. Their life is a nomadic, free, and rather shiftless one. But they can earn good wages at it sometimes, so gum-

digging often attracts broken-down gentlemen, who have been expatriated to the colony to reap the wild oats they have sown. The occupation suits them better than the restraints of any more regular industry.

I must now take you south of Auckland, into a district, the Waikato, which is remarkable in several ways. First of all, it has been the theatre of the most serious war that we have waged with any section of the Maori. Much of the land was confiscated from the rebel tribes after the war—land which they did not use, could not use, and would not be induced to use themselves, and yet would not sell to settlers. So, part of this district may be said to have been won by conquest. In other parts of it, the native title has been extinguished by purchase. Much of the land in the valleys of the Waikato and Waipa rivers is of excellent quality, and is easily broken up. Settlement has been very successful in this direction, and large pasturing is now carried on upon cultivated grass. Agriculture is also going ahead, grain and root crops mostly, here and there an acre or two of tobacco, which is manufactured at Papakura.

A railway, as also a good metalled road, runs southward from Auckland, passing a number of small towns and townships. Mercer, forty-three miles from the city, is the point where the railway connects with the river navigation. Huntly, twenty miles further on, is a colliery village. Ngaruawahia, seventy-four miles from Auckland, is built on the junction of the Waipa and Waikato; it is the centre of a thriving farm district now, though once a noted battlefield in Maori war. Twelve miles further south is Hamilton, the chief town in the Waikato, having a population of 1,361. China ware is manufactured here. The railway proceeds as far as Te Awamutu, 104 miles from Auckland. This is a very young place as yet, but has churches, hotels, courthouse, and a brewery. All the vicinity, as indeed right along the line, is a well-settled farming district.

East and west of Te Awamutu are two towns, Alexandra (204), and Cambridge (1,174), connected by road. The former is on the confines of the "king's" country, which extends to the Mokau River. Southward, there is no more settlement between these points and Lake Taupo. The country belongs to natives, who are not numerous, however; some of it is said to be valuable land. At several places along this Waikato railway there are noble bridges, and others are to be erected. The line is to be continued from Hamilton, I think, to Tauranga, and right down the valley of the Thames to Grahamstown, at the head of Hauraki Gulf. Some portions of this line are now under construction. There will also be a continuation from Te Awamutu, through the territory of the so-called Maori king, across the Mokau, and on to New Plymouth.

Grahamstown, or Thames, is the capital of the northern gold-fields, which are situated in various parts of the mountain range running down the Coromandel Peninsula from Cape Colville to Aroha. No doubt you imagine a gold-field to be a rude camp, where each man digs and washes, and "pans out" for himself. That is not the case here. On all these northern fields, the gold exists in veins in the hard rock. Each claim must be worked by a company, as a good deal of capital is required. To extricate the gold from its matrix, extensive machinery is necessary. Gold-mining here is therefore a tolerably settled avocation.

Thames is a large town. It has had 10,000 population sometimes, has now about half that number. Since its foundation in 1867, it has exported gold to the amount of about £5,000,000 sterling. You may therefore suppose it is not a rude collection of huts. It is, indeed, a comfortable town, with all the improvements and even luxuries of modern civilisation. There are piers and wharves, and much mining machinery, including a mighty pump, which drains the whole field, lifting ten tons of water per minute from a depth of 640 feet below sea-level. Public buildings and various institutions, well paved streets, and gas-lighted shops, denote complete town life. And the permanency of Thames is assured by its being the outlet for the rich farming lands of the upper river.

I was last in this district in 1876. At that time there was no settlement in the valley of the Thames, except some Maori kainga. There was the then new gold-field of Ohinemuri, sixteen miles up, on the mountain side, but the rest of the land was still a wilderness, closed to the settler by Maori ownership. Now the native title has been extinguished, and the land is being taken up. Within the last three years a gold-field has been opened at Te Aroha, thirty-six miles up, and this place is developing into a centre that will be one of importance, when communications are completed. The land around is rich, and very extensive tracts offer every inducement to farmers. From my

knowledge of it, I should say it will prove equal to the Waikato or the Wairarapa.

Tauranga is the one town with a safe harbour in the Bay of Plenty. There is a population of 2,303, half of which are Maori of the Ngaiterangi tribe. The town is a thriving and industrious one, has some good buildings, and carries on several manufactures. From Tauranga, a road extends inland, along which coaches run daily. This passes through the famous Hot Lake country, where a sort of Harrogate or Cheltenham is now being built by the Government. For not only are the marvellous geysers and terraces of these lakes of interest to sightseers, but the various mineral waters and boiling springs have medicinal virtues. The place has long been a sanatorium, and now is to be so with the addition of all possible refinements that civilisation and science can suggest. It is anticipated that it will attract numbers of tourists and invalids from India, Australia, and elsewhere.

Beyond Rotomahana and Rotorua, the coach road proceeds to Taupo, the great central lake. Here there is a township, at Tapuaeharuru. Parties go there to indulge in yachting on the lake, amid the sublime scenery, above which tower the snow-clad cones of Tongariro and Ruapehu, two great volcanoes to the south. Except a few township stations, there is no settlement along the road, which runs through 100 miles further, to Napier. Natives hold the land at present, and a good many kainga are passed on the route.

I shall now take you into the South Island, which I regret that time will not permit me to traverse so completely as I have the North. The South Island has been free from Maori troubles, and moreover, the entire territory was acquired by Government at an early date. Consequently, it has always possessed more attractions for English capital, and, as might be expected, we find in it a greater degree of wealth in private hands. The development of some of its cities and towns, too, as well as of its agricultural regions, has reached far beyond what can yet be found in the North.

For present purposes, we may divide the island into three sections. The northern, comprising all that lies north of the 43rd parallel of latitude, the old provinces of Nelson and Marlborough, with a portion of Westland. Then, taking the line of the great mountain range, the Southern Alps, we have a narrow western section, and a wide eastern one, the latter comprehending Canterbury and Otago, which I have principally to speak of.

The western division may be very briefly disposed of. It is wild, rugged, a vast stretch of rock and forest, and there is little or no settlement in it, except a marble quarry, which is now worked in Caswell Sound. The southern parts are scarcely even explored as yet. The northern section presents us with a condition of things closely resembling what we have seen in the North Island, Settlement here is not so extensive as further south, and the dominant city is Wellington, on the other side of Cook's Strait. Still, its resources are great, it possesses towns of rising importance and industries of a progressive kind.

Waimea county, lying round Blind Bay, has been called "the garden of New Zealand" by its settlers. The scenery is rich, the climate peculiarly genial, and the soil fertile. There were 12,250 acres under crop a year ago. Nelson is the chief town. Its harbour is small, its population 6,764, or, including suburbs 9,323. Its public buildings, private residences, and business premises are numerous, and afford some architectural display. It has various manufactories and industries. Only 150 miles from the capital by steamer, possessed of glorious scenery, superb climate, all the comforts of a well-provided town, together with refined and tasteful society, Nelson offers special advantages as a place of residence for well-to-do cultivated people. A railway of about thirty miles connects Nelson with some small villages inland, and there are some short coach-roads in the district. But inland, and often down to the coast, the country is mountainous and heavily timbered. These are, indeed, prevailing characteristics throughout this northern section of the island. It is here that red deer were introduced some years ago. Now, considerable herds of them roam on the hills, and deerstalking has become an acclimatised sport.

Sounds county presents a singularly broken and indented coast line. Its population is small as yet. Picton, a small town in the next county of Marlborough, having less than 1,000 population, is the chief port in this part. It is likely to progress very considerably soon, as coal is now being worked here, while auriferous quartz and other ores abound in the Sounds. Iron, copper, silver, lead, chrome, antimony, and zinc ores exist in the north, and will probably be worked; tin and graphite have also been discovered. Picton is fifty miles from Wellington; it is joined by rail to Blenheim, twenty miles off. The railway runs across the Wairau Valley, which was the

scene, in 1843, of the only conflict with Maori that the South Island has been the theatre of. A band, under the command of two famous chiefs of bye-gone times, Rauparaha and Rangihaeata, had crossed over from the North Island to prevent a settlement being formed here. They attacked a survey party, and massacred twenty-two Englishmen, including some prominent personages. The Wairau Valley contains level plains, now covered with thriving farms.

Blenheim is a quiet borough of 2,107 inhabitants, and seems to be somewhat backward. Its port is Picton. Kaikoura, the next county southward, appears to be going ahead lately. The little town and port of Kaikoura is developing rapidly. From here, and from these northern counties in general, the chief exports hitherto have been wool, tallow, dressed phormium, and timber. Agriculture is developing in Marlborough and Waimea counties, but manufacturing enterprise is inconsiderable as yet.

On the western side we have an important gold-bearing region. In Collingwood, Buller, Grey, and Westland counties, gold is worked in various places, in alluvial sand, in gravel, and in quartz-reef. A number of small towns have consequently sprung up in these regions, and other industry has been promoted. Westport, Greymouth, and Hokitika are the principal towns on the coast here; the towns inland being of less importance. Westport is the best harbour, protected by costly works. It is a good rising town, with a population of 2,000. There is a short line of rail to Rochfort, and the principal industry is coal-mining. Greymouth is also undertaking harbour works, the winds on this coast often being very fierce. It has 2,544 inhabitants, and a railway up to Lake Brunner, where coal is worked. Hokitika is the best built town of the three, showing some substantial edifices, but its harbour is a bad one. It has 2,600 population. These towns are connected by coach roads, and so with lesser places also. A coach runs from Hokitika across to Christchurch.

Gold mining in its various forms and coal mining are the main industries of these parts. But some agriculture is also carried on, and manufactories of several kinds have been started in the towns. The whole western slope of the Southern Alps appears to be auriferous, as well as the mountainous tracts to the north of them, and their southern spurs, and new gold-fields are constantly being opened in various directions. Other minerals exist; coal, which I have already noticed as being largely worked; silver and lead, and other metallic ores. Timber is exported from here to Melbourne. A promising resource of the west coast is the phormium, or Maori flax, which here attains its maximum in both quality and quantity. Industries connected with it are thriving, and rope and canvas manufactories are beginning to do an important trade. Farmers, pastoral and agricultural, are much wanted in the west. There is plenty of land suitable for them, and a large market among the mining population. The climate is inviting in the valleys. Reefton, a town of about 1,000 population in Inangahua county, is rather an important place, gold and coal being mined there; through it passes the road from Hokitika and Greymouth to Nelson. Other towns of the north-western region present a good deal of resemblance to the mining camps of California, with which the works of Bret Harte have made us all familiar. Twenty miles south of Hokitika is Ross, a town of 1,139 population. Seventy miles further is the township of Okarita, where the road ends, and with it, practically, civilisation and settlement. The southern half of the western side of the island is a total wilderness.

I come now to the most important section of the island, that comprehending the provincial districts of Otago and Canterbury. This is, at present, the most important part of New Zealand altogether. Here we have greater capital, a larger population, more extensive production and manufacture, consequently a far greater amount of business and commerce, than in any part that I have hitherto spoken of. We have two great cities, several large and busy towns, besides growing centres of lesser size. There is a trunk railroad 400 miles in length, having branches and extensions making nearly 1,000 miles in all, and being annually added to. Roads traverse the country in every direction, and bring parts distant from rail or river into communication with them. Great plains covered with natural grass afford pasture for countless flocks and herds; and now, too, agricultural farming is being conducted on a large and increasing scale. Here you find conditions of life approximating closely to English, American, and Australian existence, both urban and rural, with the first of which the people, the climate, the productions, and the commerce are in accord. It is a new young Britain in a very decided sense.

The prospects of the whole country, but more particularly of this section of it, look very promising. It is here that the farmer and the merchant see an exceptionally bright promise before them, in the proposed construction of a canal or railway across the Isthmus of Panama, an undertaking which we shall doubtless see one day accomplished. This would be a shorter road to England and Europe, and New Zealand proposes to supply us here with many things, not the least of which are breadstuffs and meat.

You have, perhaps, been scarcely prepared to regard New Zealand as a grain-growing country; yet it will be so to a great extent; and in the section of the South Island that we are now considering it is so already. Much has been done, but a very small proportion of what will be done in developing agriculture. The area of the whole country is estimated at about 64,000,000 acres. Of this, 12,000,000 acres are reckoned as first-class agricultural land; 50,000,000 acres as more fitted for pastoral purposes, but of which a large part may yet become agricultural land, eventually. Of the whole, 20,000,000 acres are covered with timber, 2,000,000 acres are barren mountain.

The following agricultural statistics may be useful. Last year—1882—there were in the colony 3,638,069 acres under sown and cultivated grass; 1,002,485 acres under various crops; of which 365,715 acres were under wheat, 304,818 acres under oats, and 29,808 acres under barley. You thus see what a very small proportion (about 1-12th) of even the first-class agricultural land has yet been brought under crop. There is an impression prevailing in England that New Zealand is getting crowded, as far as the farm lands are concerned, and that not much is left available to agriculturists. This impression I am anxious to correct. No doubt it has arisen from the fact that the Crown lands in the South Island are mostly disposed of. But this is not to be taken as implying that you cannot now buy land there; you can certainly do so; but you buy from private owners, and, of course, at an advance upon former prices. Nor does it imply that the land disposed of by the Government has all been settled and taken up. This is far from being the case, putting aside the question of the wide tracts leased as cattle-runs and sheep-walks.

I am desirous of proving to you the enormous capabilities of New Zealand as a wheat-raising country, and the possibilities of the future in regard to this item. The industry is yet in its veriest infancy, but enough has been done to show what may, and will be, accomplished in coming years. From the returns of last autumn—that is, of February, 1882—I quoted 365,715 acres as being the total area in the colony under wheat crops. The yield was 1,037,236 quarters, giving an average of rather more than 22 bushels per acre. The previous year New Zealand had exported 670,157 quarters of wheat, value £745,739, nearly the whole of this being sent to Great Britain.

So, the New Zealand farmer has already begun to enter into competition with his fellow of Manitoba and the prairie lands of North America, in supplying us here with corn, though what he has so far done be only an index of what he will eventually accomplish. 365,715 acres under wheat has served for a foundation to the grain trade; but this extent is only a tithe of the 12,000,000 acres—at least—which are suited for the corn-raiser. It is profitable now to the New Zealand cultivator to send his produce to Great Britain, in spite of present disadvantages. But when transit across Panama is rendered feasible, the cost of placing wheat on the London market should be lessened from the 1s. 8d. per bushel at which it stands at present, and the profits of the grower will be consequently greater.

Corn-raising in New Zealand must be considerably more advantageous than in North America. The virgin soil of the colony returns an average crop of twenty-two bushels per acre, about double the average of the prairies. An average of thirty to forty bushels has been reaped in some districts, and ninety bushels of oats has been known. Then, having no severe winter to contend against, the New Zealand farmer can generally utilise his land for a second crop, of roots or other produce, and can also make use of his straw. His crop is also far heavier than what is raised in Australia, where, moreover, droughts often render wheat a failure. He has a home market and an Australian market, besides an English one.

I have drawn your attention, already, to various districts where agriculture is beginning, or where the land is exceptionally well fitted for it. But it is in the south-eastern part of the South Island that most farming has yet been done. By far the greatest part of the land now in cultivation is located here, and the production of other districts has been slight, as compared with the production of this. This applies to the present only, though, for

the North Island, and the northern section of the South as well, will show substantial returns by-and-bye.

Agriculture is being more and more largely resorted to in all the counties of the south-east section, grain and other crops being raised in all. But the chief wheat-growing counties as yet are Ashley, Selwyn, Ashburton, Geraldine, Waimate, Waitaki, and Southland. Still, in Waikouaiti, Taieri, Tuapeka, Bruce, Clutha, Lake, and Wallace, agriculture is promising, and large harvests of corn will yet be reaped in them also. The stockman and shepherd are here giving way to the steam-plough, just as the export of wool and tallow and hides is being encroached upon by the demands of local manufacturers.

The New Zealand of the future will be a country exporting her own manufactured goods rather than her raw produce. The beginnings of this are already evident, and, as we might expect, are chiefly apparent in the Otago and Canterbury districts. Take the item of wool, which, as you know, has been one of the main exports of the colony. In 1880 the quantity exported was 66,860,150 lbs., value £3,169,300. There was a slight decrease the following year. But there are now four woollen factories at work, soon to be followed by others. The aggregate valuation of their plant is £100,000, about, and they employ 417 hands. The factory at Mosgiel, near Dunedin, is turning out tweeds that already have a considerable repute. In 1881 the profits of this establishment were £6,930, giving a ten per cent. dividend to the shareholders. There is a reserve, too, of £10,000. At Roslyn, a suburb of Dunedin, there is another woollen factory, which cost £60,000, for buildings and machinery. In the rapidly rising town of Oamaru there is another. The fourth is at Kaiapoi, in Ashley county. This last has 1,440 spindles and 30 looms, and it is said that it can turn out 1,000 pairs of blankets, and 6,000 yards of flannel per week.

These figures may not seem very large, perhaps; but Manchester and Glasgow had small beginnings too, and the development of manufacturing centres in New Zealand will be more rapid, because of the increased facilities procurable in these latter days. Wool and woollen manufactures have the most important bearing on the future of the country. It is doubtful if the wool-growing capacity of the colony has reached anything like its ultimate maximum. The great sheep-walks of natural pasture must certainly diminish year by year, as agriculture is more resorted to. On the contrary, land at present covered with useless fern and scrub, or with forest, annually yields a larger and larger area to the settler, which is broken up and put under grass—made into meadows and paddocks, in short; and this will feed more sheep to the acre than the other; so that the flocks may be even increased in number, although the present pastures be more encroached on by the plough.

While I am on this subject of the sheep-walks, I may just make mention of a disastrous importation, of which we have heard a good deal lately, and that is—rabbits. Fourteen or fifteen years ago, a number of gentlemen at Invercargill, assembled at a banquet to celebrate the occasion of turning loose some pairs of English rabbits. These have multiplied so enormously, and have spread to such an extent, that the damage they have done by consuming the grass on the runs has caused very serious loss to sheep-owners. A war of extermination has been proclaimed, and every possible means resorted to for destroying these undesirable colonists. Their skins have become an article of export. In 1881, the colony exported 8,514,685 skins, value £84,774, which would be used for felt-making, &c. Still, the loss has been great, and the rabbits multiply faster than they are destroyed.

Yet it is possible that this plague of rabbits may be not an unmitigated curse after all. Indeed, there are some ready to pronounce it a blessing in disguise. The holders of great stretches of natural pasture have always been disinclined to sell or lease any part of their territory to farmers. But now they are faced by a loss which has compelled or induced many of them to break up their lands, and sell to the agriculturist. For the latter, cultivating a few hundred acres, can effectually protect himself and keep the rabbits in check. The rabbit plague, therefore, may be one of the causes which will hasten the bringing under grain crops those lands in New Zealand which are really the most suitable for such a purpose. The sheep-owner may lose, but the grain-grower will gain, and so indeed will the country at large.

Maritime enterprise is bound to develop largely in New Zealand. There are now 443 sailing vessels built and registered in the colony, total tonnage 56,751 tons, and 129 steamers, giving 15,636 tons. Yet this is scarcely more than a beginning. And there are twenty-eight principal ports of entry, most of them well provided with facilities for ship-

ping, some of them with extensive and costly harbour-works, docks, &c. The world of commerce will yet hear a good deal from the shipbuilding yards of New Zealand.

Coal and iron, which have done so much in aiding the development of Great Britain, will have an immense influence on the future of her Antipodean analogue. There are fifty-one collieries in New Zealand, and some small workings, employing nearly 1,000 hands, and turning out 299,923 tons of coal in the year. This, too, is but a commencement. The smelting of iron from its ores has yet only been tried experimentally, but the country is rich in iron ores of various qualities, and the working of these is loudly demanded. There are thirty-five foundries at work in various towns, employing 952 hands, and turning out machinery of every kind, for use in the various industries undertaken in the colony. This is a business of such considerable and rapidly advancing importance, that it must soon necessitate the conduct of operations on a large scale for the reduction of New Zealand ores.

There is much more that I should have liked to have said concerning the industries and undertakings of the colony, but the limits of one short paper could not contain a tithe of what I might say. I should like to have said something of the postal and telegraph services, and more particularly of the railway system. This, indeed, from its rapidly advancing extent, from the progress it incites and impels, and from the fact that it is a strictly national system, has such an immense bearing on the future of New Zealand, and on her public finance, that it might advisably be treated alone.

I could wish to have described Dunedin, the largest and most striking of New Zealand cities, with its 42,802 inhabitants, its air of Scottish prudence tinctured with American activity, its munificent institutions, noble buildings, palatial residences, and large business. So, too, Christchurch, city of the shepherd princes, where you may find, perhaps, the highest degree of social refinement in the country, and in extent, in architecture, in industry and trade, the friendly rival of Dunedin, from which it is 230 miles distant. And then there are the rising towns of Oamaru, Timaru, Invercargill, and Riverton, concerning which a great deal might be said. And the counties of this eastern section, with their boroughs and townships, their railways and roads, their pastures and cornfields, their rivers, lakes, and mountains, their gold mines and collieries, and the many avocations of their people—all this might form a theme for many papers, not merely for a portion of but one.

I have unavoidably been very discursive, for it has been my aim to convey to you a varied picture. In its social and commercial aspects New Zealand presents many points of internal difference, some of which I have tried to indicate, many separate details on which the mind can rest, that I could only briefly notice. There is much, therefore, to which I have scarcely alluded, which I hope you will not feel disappointed in my omitting, for a paper such as this might be extended indefinitely.

In conclusion, let me say that I have no disposition to extol New Zealand beyond what I consider her just merit. As a sometime colonist, no doubt I am partial. Yet I am not alone in deeming New Zealand the finest child in Britain's colonial family, not alone in being her lover as such. She is one of Britain's youngest children, now just in her teens, blushing and bright with youthful beauty, full of hope and promise, glad new life and energy. And I can say no more for her than this, can surely give her no higher praise than to trace her resemblance to her parent—the brighter counterpart of a fair mother-country! — *Matre pulchra, filia pulchrior!*

DISCUSSION.

Mr. H. Moncriett Paul said he could not attempt to follow Mr. Hay through the whole of his elaborate paper, but there were one or two points affecting the progress of the colony which he would like to touch upon. And first, with regard to gold; this was always an important factor in attracting population to a new colony, and this in two ways. First, on account of the inherent thirst for gold in the human mind, and, secondly, because those who went to search for gold were always large consumers of produce. Before the gold discoveries, the Australasian colonies had, to some extent, been weighed down under the iron age, but a new era dawned upon them in 1851; and nine or ten years after the discovery of gold in Australia, it was also found in New Zealand, and the effects proved most important. It had attracted population, and increased consumptive power. At first, when it was worked in the alluvial deposits, there were a great many masters and no servants; but when the era of deep-sinking and quartz-mining arrived, capital and brains had to be brought to bear. Then, after a time,

men who had acquired money by storekeeping, got tired of the din and bustle of the goldfields, and, seeking for rest, purchased land and became farmers, and thus the agricultural interest became developed. Before the discovery of gold, wool was, and it still remains, the most important factor in the prosperity of New Zealand. Going back to 1874, the export was 47,000,000 lbs., but in 1881 it was 64,000,000 lbs. Another remarkable feature was that, while the stock had not greatly increased in numbers, they had altered in character. In 1874, there were imported into England 104,000 bales, each between 300 lbs. and 400 lbs. weight, whilst in 1882 there were 194,000 bales; but in 1872 only about 15½ per cent. were the produce of what were termed coarse wool sheep, whilst in 1882 the proportion had risen to 53 per cent., showing a vast increase in the small farming interest, and in the growing of cross-bred sheep, for which New Zealand was specially adapted. This wool was fast displacing native grown, as it was found to work up much better than either English, Irish, or Scotch. Akin to this subject was that of frozen meat, which was at present in its infancy, but would eventually become most important. The sheep in New Zealand had only increased from 11½ millions in 1872, to about 13 millions in 1882; but there were special reasons for that. Some years ago there were very heavy snowstorms, in consequence of which 1½ millions were lost in one year, but that was being rapidly made up; and, as small farms developed, the increase would be greater, and the surplus would be available for refrigeration and export. For the year ending September, 1882, the export of frozen meat was only 11,412 cwts., but the day was not far distant when, from New Zealand alone, we should probably receive half a million frozen carcases annually, and the meat was better adapted to the English market than that of any other of the Australasian colonies. Even during the last year he found there was a great increase in the demand for this meat. No doubt it was unfortunate that rabbits had been introduced, but, as Mr. Hay had said, it was by no means an unmitigated evil. The value of the skins last year was, he believed, about £170,000. There was a Rabbit Act, which would cause people to adopt the most stringent measures to put them down; and there was no doubt that, with the further cultivation of the land, they might be exterminated in certain districts. Coming to another article, wheat, he found that the produce in 1873 was 3,400,000 bushels, an average of 25½ bushels per acre; in 1881 the total produce was 8,298,000 bushels, an average per acre of 23½; in the intervening period, the average had been higher than either figure, but the latter was by no means one to be ashamed of. As he had remarked before, all sorts of people went into farming, and husbandry was not carried on in the same style as in England, so that the natural capabilities of the soil must be exceptionally good. There were great varieties in the character of the grain, owing to differences of soil, climate, and method of farming, for he found the price in England ranged from 40s. to 50s. per quarter, whilst the difference in price in Australian wheat did not vary more than 2s. He believed the time would come when New Zealand would grow wheat for the greater part of South Australia, where the decrease in the growth of this cereal was very remarkable. Oats, again, would come very much to the front in future, the produce having risen from 3,292,000 bushels in 1873, to 6,924,848 in 1881, the latter being an average of 28½ bushels per acre, and the quality was very good, so that they were much esteemed in some racing stables in England. Kauri gum was an article very little known in England, but in America, where varnish was very largely used for furniture, it met a very ready sale; nearly four-fifths of it going to that country. The railways of New Zealand had very much developed; in 1873, there were only 145 miles open, and, in 1881, there were 1,287. It was well known that savages did disappear before civilisation, and the Maories must be classed as savages, though they might be a superior type. If they wished to prevent the Maories disappearing, they must be raised by civilisation and education; as a fact, the decadence of the native population was not nearly so rapid as was at one time supposed.

The CHAIRMAN said Mr. Hay and Mr. Paul had given a most delightful picture of the material prosperity of New Zealand, showing that every industry known to commerce flourished there in a high degree; the mining, agricultural, and pastoral interests were all progressing rapidly, and yet they had only just commenced, so that there was abundant scope for English capital and energy in developing all of them. And all this had been done not only without injury to anyone, but with great benefit to the original proprietors of the land. It had been a theory with many people that the occupation of New Zealand by the white man had been the destruction of the native; but he maintained that, so far from that being the case, the occupation of the country by Englishmen had been the salvation of the New Zealand tribes. He was amongst the first settlers who went there, and at that time the various tribes were at such deadly enmity that they were fast exterminating one another. They had nearly achieved that end in the southern island, and were rapidly carrying it out in the northern. If, at that time, you wanted a guide to explore the country, you had to get a fresh one at the edge of every tribe's territory, for the first one dare not enter on the lands of his neighbour, knowing that he would be certainly killed, and very likely eaten. It had been said that the land was purchased from the natives at a merely nominal price, and that in fact they were cheated out of their lands, but remembering that the population was never more during our knowledge of the islands than 60,000—at present from 30,000 to 40,000—and that New Zealand contained upwards of sixty millions of acres, and also that these people were neither hunters nor nomadic, that they

existed on particular spots, and could only live on what land they cultivated, it could be easily calculated how much of this large territory 60,000 people could make use of. It was then evident that by far the greater portion of the land was utterly useless to the natives, and consequently, if they got for a large number of acres, which were of no earthly use to them, a blanket, or an axe, or a keg of powder, they were so much the better off. But this was not the only question. By the occupation of the land by Europeans, that portion which remained to the natives acquired an appreciable value. This was shown by the remark made in the paper as to the confiscated land, which he would illustrate in this way. There was not a piece of land in New Zealand possessed by the Government, or by any individual settler, which had not been obtained with as much legal form as any piece of land in England. It had never been taken by the Government—except in the case of this confiscated land—unless by the will of the native himself. When the settlers first arrived, they bought land from the natives occupying it, and took as much trouble as they possibly could to ascertain the rightful owners; but after they had occupied it for some time, other tribes came forward and said—"It is all very well to say you bought that land, but we conquered those tribes long ago, or they conquered us, and we were the rightful owners thirty or forty years ago, and were driven off; now we have become powerful enough to dispute it with them, and we maintain you must buy it from us." Consequently they forced us to go to war to defend the land we believed we had legally bought from the tribes occupying it. Of course, in the end, the English were victorious, and in order to punish those who had behaved unjustly, confiscated their land, in order to prove to them, by their own customs, that they were conquered. They still had a great deal more than they could properly use, and of late the majority of the natives had come into our ways, and were living very quietly and happily. There were certain sections who still retained their own habits and customs, and would not admit European settlers amongst them, but even they had recently allowed roads to be made through their territory, and had given in their adhesion to the Government. Now this confiscated land had been distributed amongst settlers, and had, in great part, come under cultivation, and the consequence was that, according to a calculation he recently saw, the land still belonging to about 4,000 natives would, if put into the market, be worth a million and a-half sterling, while, when the European settlers first went there, it was not worth a farthing to anybody. It might be interesting to know that not only the native but the European children had the benefit of as good an education in New Zealand as they could get in England or elsewhere, and on that point he would read what had been sent to him by Mr. Lant Carpenter, the English agent for the University of New Zealand :—

Mr. Carpenter said, in reference to education, that he wished to draw attention to the marked progress that is being made. "In every town that I visited in 1880 and 1881, I found a small circle of highly educated men, chiefly among the professional classes, who, by diligent reading, kept themselves quite abreast of the Old World progress in science, and, to a less extent, in literature. Measures are now being taken to promote higher education in the colony generally, both by the establishment of high schools, and of colleges. The great care exercised in the appointments to the staff of these has come before me practically several times since my return to England. In making his selection, the Agent-General of the colony in England is largely guided by the advice of a small committee of two or three experts in that particular branch of science or literature, and I can, of my own knowledge, testify to the great excellence of some of these recent appointments. In the case of all the colleges, &c., the wisdom of the Government (local or otherwise) has taken care that there shall be no lack of funds for their maintenance, derivable, in many instances, from land assigned for such purposes in the early days of the colony. In the case of the so-called University of Otago, or College (for it has no power of conferring degrees), at Dunedin, for example, 214,000 acres of land were so assigned, and, in 1875, its yearly increase was £3,000; since then two capital sums of £27,000 and £11,000 have been made over to it, besides the whole of the ground on which the new buildings have been erected. A very liberal provision has, I understand, been made for the new college just being started in Auckland, and will be for a similar one in Wellington. The college at Christchurch is beautifully situated in suitable and commodious buildings, and has the great advantage of nearness to the admirable museum organised and superintended by Dr. Von Haast. Nor should I omit to mention, among the educational facilities, the spacious and well organised town museum at Dunedin, and the admirable Colonial Museum at Wellington. The University of New Zealand is, at present, much like what the University of London was thirty years ago. It is simply an examining Board, and grants degrees to students who keep their terms at one or other of the affiliated colleges before mentioned. Under the University Endowment Act of 1868, certain lands were reserved for the future University, which was incorporated in 1871. Its headquarters are in Christchurch. The matriculation examination is conducted by colonial examiners, but the senate is so anxious to maintain a high standard for its degrees, that arrangements have been made by which the 'pass,' 'honours,' and 'scholarship' papers are set by English examiners, who revise the answers which are worked in the colonies."

This showed what rapid steps had been taken by the colony, which might be called England's youngest

child. The first settlers arrived in New Zealand in 1839 and 1840, and within about forty years that colony, from the admirable character of the soil and climate, had been turned from an absolute savage wilderness, into one of the finest and most prosperous colonies England possessed. The Chairman concluded by proposing a cordial vote of thanks to Mr. Hay for his admirable paper.

The vote of thanks having been carried,

Mr. LIGGINS said this paper would be most interesting to the whole country. He thought if a *résumé* of the paper could be printed and circulated, it would be a great benefit to a large number of struggling people, who wanted to know where to go. He always recommended his fellow countrymen, if they had to leave home, to select one of our own colonies, instead of going to a country like the United States, where there was a terrible amount of competition amongst the working classes and different races, which did not always amalgamate in the most harmonious manner. If New Zealand were not so far off, he believed it would be more generally selected; but owing to the distance, people did not hear so much about it.

Mr. PFOUNDES endorsed Mr. Liggins's suggestion, and said he should be glad to see copies of such a paper distributed.

Miscellaneous.

THE GOVERNMENT PATENT BILL.

The Government Patent Bill has been printed. It has, on its back, the names of Mr. Chamberlain, the Solicitor-General, and Mr. John Holmes. Besides dealing with patents, it also consolidates, and, in some respects, modifies the existing law for the registration of designs and trade-marks. All these are to be under a Comptroller-General of Patents, Designs, and Trade-marks, who is to act under the superintendence and direction of the Board of Trade. The Act of 1852, under which the Commissioners of Patents were appointed, being repealed, they are consequently abolished.

For the present it may be sufficient to consider the parts of the Bill relating to patents. As regards the application for a patent, the principal alteration on the present system is that the provisional specification filed with the application is to be referred to an examiner, a sufficient number of examiners being appointed under the Bill. He is to report whether the invention is subject-matter for a patent, whether the nature of the invention has been fairly described, and if the application has been properly prepared. The comptroller may refuse the application, if the examiner reports that the invention is not subject-matter. If the report is adverse on the other grounds, the application, &c., must be amended. In either case, there is an appeal from the comptroller to the law officer. Nine months after the date of the application, the applicant is to leave a complete specification. This is examined with the provisional, for the purpose of ascertaining whether the two documents agree, and whether the complete specification has been properly prepared. In the case of an adverse report, the specification may be refused; but the applicant has, as before, an appeal to the law officer. If the complete specification be not accepted within twelve months, the application becomes void. The acceptance of the complete specification is to be advertised, and it is then open to public inspection. Within two months after the first advertisement, the application is open to opposition, which is before the law officer. The law officer is to hear the applicant, and any person in his opinion entitled to be heard in opposition. He may, if he likes, obtain the assistance of an expert. If there is no opposition, or if opposition is overruled, the patent is to be sealed within fifteen months from the date of application. If, with his original application, the applicant prefers to file a complete specification, it is treated in the same manner as above, except, of course, that there is no examination as to its agreement with the provisional. It will be noticed that the system of examination proposed is practically identical with that suggested, for the first time, in the Society of Arts' Bill. The term of the patent is fourteen years. The fee on application is £1, on the grant £3; at the end of the fourth year there is a fee of £50, at the end of the seventh a fee of £100, payable on the taking out of a certificate of renewal. An applicant or a patentee may amend his specification, after notice duly given; this is subject to opposition, to be heard before the law officer. Should there be no opposition, the comptroller may determine "whether, and subject to what conditions (if any)" the amendment may be allowed. If the comptroller refuses leave, there is an appeal to the law officer. No amendment is to be allowed which would make the specification claim an invention "substantially larger than, or substantially different from, the original invention." In an action for infringement, a patentee may, on obtaining an order of Court, be allowed to disclaim any part of his invention. The Board of Trade may order a patentee to grant licenses on its being shown that the patent is not being worked within the United Kingdom, that the requirements of the public are not supplied, that any person is prevented from working to the best advantage an invention of which he is possessed. This clause corresponds very closely with the Society of Arts' proposal for compulsory licenses. As to the prolongation of patents, or as it is termed in the Bill, extension, the present

system of application to the Privy Council is practically preserved. The revocation of the patent may be obtained on petition to the High Court of Justice, instead of the obsolete proceeding by *scire facias*. Certain regulations are introduced with reference to the conduct of actions for infringement. Amongst them is one that the Court shall, on the request of either party, call in the aid of a specially qualified assessor. Every patent is to be granted for one invention only, but the defendant in a patent action is not allowed to take objection to the patent on the ground that it comprises more than one invention. The existing Act as to the protection of inventions at exhibitions is repealed, and clauses embodying similar provisions are provided. The Act of 1859, as to the assignment to the Secretary at War of certain inventions dealing with munitions of war, is treated in the same way. The Patent Museum is to be transferred to the Science and Art Department. The comptroller is directed to issue periodically an illustrated journal of patented inventions, which is to contain reports of patent cases and other information which may be considered useful. By one of the definitions, "invention" is stated to mean any manner of new manufacture coming under the sixth section of the Statute of Monopolies. In a memorandum prefixed to the Bill, it is stated that arrangements will be made for the sale of the various forms required at post-offices throughout the country. Applications may be made through the post-office, and thus it will not be necessary for persons residing in the country either to come to London themselves, or to employ a London agent.

Comparing this Bill with the Society of Arts' Bill, it will be seen that the two Bills have several important points in common. The system of examination of applications is practically that suggested in the Society's Bill, and the same may be said of the clause relating to compulsory licenses, while the provisions as to amendment are very similar. So far as regards the abolition of the *ex-officio* Commissioners, the two Bills are the same; but while the Society's Bill proposed a commission of at least three members, the Government Bill substitutes a single officer. In both Bills the term of Provisional Protection is extended, in the Society's to nine months, in the Government Bill to twelve. The duration of the patent is kept as now, whereas the Society's Bill proposed a longer term, seventeen years. The fees for the first period are considerably lower than those suggested in the Society's Bill, but the total fees in the Society's Bill are only half those of the Government's. The proposals dealing with the trial of patent actions may be considered so far to have found favour with the Government, that they have adopted the idea of giving the litigants power to call for an assessor, though the Government Bill does not go so far in this direction as the Society's. In providing for enlargement of time for the payment of fees, &c., the Bills closely resemble one another. The Government Bill makes no attempt to define what is subject-matter for a patent, preferring to rely on the modern interpretation of the ancient definition of the Statute of Monopolies. The provision for sending applications, &c., by post, was introduced in the Society's Bill. There are other provisions in which the two Bills cover common ground, but most of these may be considered to be such as would of necessity have been introduced into any properly drawn Bill for the amendment of the Patent-law.

Correspondence.

THE ANTISEPTIC ACTION OF SPONGY IRON.

Dr. Bischof, in his communication of last week, says, with reference to my letter on "The Chemical Analysis of Water" of the 9th instant:—"Mr. Jabez Hogg renews a discussion which it might have been expected was carried far enough at the Institution of Civil Engineers to prove that he made a mistake." I am quite unable to discover the "mistake" he alludes to, and there certainly was no mistake on my part of the utter failure of the spongy iron filter to kill, or, as Dr. Bischof puts it, "destroy the germs of putrefactive bacteria, and possibly those of epidemic diseases." My experiments, performed with due care in every way, show that the spongy iron filter will not destroy infective germs, and I must confess that I entirely fail to see the relevancy of the preservation of butter, which he imports into the question, with that of "the chemical analysis of drinking water." It is a well-known fact that butter and animal substances, if preserved from atmospheric contact, can be kept sweet for a lengthened period. I repeat what I said at the meeting of the Institution of Civil Engineers, that my experiments were conducted with great care, and with a desire to form a perfectly honest opinion as to my results, and no more. I have since repeated my experiments with every precaution, and upon a specimen of water sent to me from Antwerp, collected under chemical supervision, and at this cold period of the year, the temperature of the water being only 38° Fahr., and these have also broken down under the gelatine and microscope tests. I am perfectly justified, then, in concluding, it is not because Dr. Bischof tells us that it is the object of the spongy iron filter "to destroy certain specific poisons," that the spongy iron filter will actually accomplish this, and secure a constant supply of drinking water.

The spongy iron filter does exert some chemical or mechanical action in water; nevertheless, like other filters, it is only to be actually depended upon for separating the coarser matters suspended in water—

and which are, for the most part, harmful—from those that are finer and, probably, more dangerous. This will naturally impart a bright and brilliant look to almost any water; but water so treated may yet contain the germs of death, and arrangements, devised with the best intentions, for their complete exclusion will not avail much, as the seeds or germs of bacteria are so minute and impalpable that they are carried about by every breath of air, and a single drop of water is sufficient to start them into life. Water is their natural habitat; in it they live and multiply to an almost incredible extent. What then can we expect "common sense" to do for us in guarding filters in daily use against re-infection? These specific poison germs exist in the extremes of cold and heat of strong anti-corrosive fluids; why then does Dr. Bischof expect spongy iron shall kill them? A saturated solution of carbolic acid, although apparently effective for the destruction of some forms of micro-organisms, will not destroy the germs of a specific bacilli. Indeed, some of the latter, after immersion for a month in fuming nitric acid, I have discovered very little the worse for confinement in their new and extraordinary conditions of life.

Dr. Bischof employs, he tells us, "covered reservoirs," both in Antwerp and London, for the purpose of preventing re-infection, by suction, during filtration of the water. Does he seriously believe that covered reservoirs will remove all chance of infection by atmospheric contact, for all time, and during each stage of his water filtration? I fear he will not gain much by his covered reservoirs.

What, then, is the proper course to pursue? That which I have so often recommended. We must draw our water from natural sources, which are neither contaminated nor contaminable. Our only security is a resort to deep wells; and the drinking water of communities and individuals should only be taken from such sources. In London this could very easily be accomplished, as within a circuit of thirty miles there are 100,000,000 gallons of pure spring water running to waste. Here, then, is the remedy against pollution; and a bountiful supply, supplied by nature, for all culinary and drinking purposes. Why should London be debarred from tapping this source of pure and wholesome water?

One last word with respect to spongy iron filters. I notice that spongy iron exerts a *de*-oxidising effect upon water; and, also, on standing a glass bottle of filtered water by for a few days, a considerable deposit of red oxide takes place. There is, probably, no great harm to be apprehended from the later; but water, bereft of its oxygen, is neither very palatable nor perfectly wholesome. For this reason it becomes absolutely necessary once more to restore this important element—oxygen—to spongy iron filtered water, and this is done at the Antwerp water-works.

It is now placed beyond a doubt that all the various processes adopted by chemists, more or less, miss their mark. They all, indeed, destroy without discovering the more pernicious micro-organisms contained in their specimens. This I have insisted upon and pointed out, and it has been once unmistakeably demonstrated by the Medical Department of the Local Government Board. Dr. Cory has directed a series of experiments which clearly prove that a chemical examination will not distinguish between an excremental pollution of water and that taken from a pure source; so "the lesson is taught us afresh and significantly, that while we must ever be on the watch for the indications that chemistry affords of contaminating matters gaining access to our waters, we must go beyond the laboratory for evidence of any drinking waters being free from dangerous organic pollution. The chemist can tell us of impurity and hazard, but not of purity and safety. For information about these we must go, with the aid of what the chemist has been able to teach us, in search of the conditions surrounding water sources and affecting water services."

JABEZ HOGG.

1, Bedford-square,
March 19, 1883.

UTILISATION OF DISEASED POTATOES.

I know from practical experience that M. Bourlier and M. Hervé (see *ante* p. 444) are quite correct as to the value of diseased potatoes as an article of food for cattle, pigs, &c., but the most important item to be observed, they omit in their directions, which I revise as follows:—

Boil the diseased tubers fast till done; drain, and let them become perfectly dry by spreading them out on sieves—a gravel screen is the best. The tuber, when cooked, is free from poison; the water in which it is boiled is a very strong poison, and will scour, if not kill, any animal that partakes of it. When dry, ram tight into any kind of dry cask (with salt), and keep in a cool place till wanted. One copperful can be dried and packed while the next is cooking, so that a large quantity can be cooked in one day. Every farmer should know this, as it would save him suffering any loss, however bad his crop might be.

GEO. WM. PASCALL.

Chelmsford, 20th March, 1883.

General Notes.

MUNICH ART EXHIBITION.—The opening of the proposed International Art Exhibition, which has already been referred to in the *Journal* (see *ante* p. 136), is now fixed for the 1st of July. Works intended for exhibition must be sent before the 31st of May next, but the Committee will not be responsible for anything sent before the 1st of May.

Journal of the Society of Arts.

No. 1,584. Vol. XXXI.

FRIDAY, MARCH 30, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PREMIUMS FOR THE 129th SESSION.

John Stock Prize.

Under the will of John Stock (1781), funds were bequeathed for the promotion of "Drawing, Sculpture, and Architecture."

A Society's Gold Medal, or £20, is now offered for the best design from a poem, or from history, or from the Scriptures, prepared with a view to Mural Decoration.

Benjamin Shaw Prize.

Benjamin Shaw, in 1879, presented the Society with a sum of money, the interest of which is applied in Prizes for "Industrial Hygiene."

Under this trust, the following two prizes are now offered:—

1. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the operations of coal-mining."

2. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the manufacture, storage, and transport of explosives."

*** The Council leave it to the competitors to bring the plans under their notice in any way they may think proper, whether by model, written description, or otherwise.

Howard Prize.

Under the will of Thomas Howard (1868), funds were bequeathed for the periodical award of a prize for an Essay on Steam or Motive Power, or for an invention connected therewith. A prize of £100 is now offered for the best Essay on the Utilisation of Electricity for Motive Power. Preference will be given to that Essay which, besides setting forth the theory of the subject, contains records with detailed results of actual working or experiment. The Society reserves the right of publishing the prize essay.

Fothergill Prize.

Under the will of Dr. Fothergill (1821), funds were bequeathed for the offer of Medals for subjects, in the first instance, relating to the Prevention of Fire. A Society's Gold Medal, or £20, is now offered for the best Invention having for its object the Prevention or Extinction of Fires in Theatres, or other places of public amusement.

Mulready Prize.

The Council of the Society hold certain funds, balance of the amount subscribed for a Mulready Memorial, the interest of which is to be expended (amongst other purposes) in providing, occasionally, a medal to be awarded "To that student in a School of Art in the United Kingdom who exhibits the best Drawing from the nude figure, executed in black and red chalk, in the manner so successfully practised by Mulready."

A Society's Gold Medal is now offered under the above conditions.

Designs, plans, models, essays, descriptions, inventions, &c., intended to compete for any of the above Prizes, must be sent in on or before the 31st October, 1883, to the Secretary of the Society of Arts, John-street, Adelphi, London.

The Council reserve the right of withholding any or all of the above Prizes or of awarding others of lesser value in their stead, in any case in which there is nothing in their opinion deserving the award, or sufficiently complying with the conditions, sent in for competition.

H. Trueman Wood, *Secretary.*

Proceedings of the Society.

CHEMICAL SECTION.

Thursday, March 22, 1883; Professor Abel, C.B., F.R.S., in the chair.

The paper read was—

THE SELF-PURIFICATION OF PEATY RIVERS.

By W. N. Hartley, F.R.S.E.
Professor of Chemistry, Royal College of Science, Dublin.

Those chemists who are well acquainted with the classic researches of M. Pasteur, must

have experienced a feeling of surprise when informed in the pages of the *Journal of the Chemical Society* that organic matter of a particularly stable character was oxidised and destroyed by the oxygen dissolved in water, under the influence of a comparatively low temperature. M. Pasteur has shown that, even at a temperature of 30° C., the oxygen of the air has but a very trifling action on extremely changeable material, such as the albumenoid matter in yeast water, or a solution of sugar. ("Annales de Chimie et de Physique," 3rd series, vol. lxiv., pp. 35 and 36, also p. 71.)

Miss Lucy Halcrow and Dr. Frankland (*Journal of the Chemical Society*, vol. xxxvii., p. 506, Trans.) describe certain experiments, made with the object of testing Dr. Tidy's conclusions, that peaty water in the River Shannon loses more than 38 per cent. of its organic elements by oxidation, during a flow of only one mile. They contend that if peaty water possesses this extraordinary affinity for oxygen at ordinary temperatures, it cannot be necessary to appeal for proofs of it to large bodies of water, which are always liable, more or less, to alterations in the proportion of their organic elements from other causes.

They tried, first, the effect upon air of prolonged exposure of peaty water to daylight, but without agitation; second, the effect upon air of violent agitation with peaty water; third, the effect upon air of violent agitation with waters free from oxidisable organic matter. Their experiments lead to the conclusion that, if peaty matter dissolved in river water is spontaneously oxidised at all (of which they consider there is no sufficient proof), the process takes place with extreme slowness, and cannot be accomplished to any considerable extent in the flow of a river. The evidence proved the fact that peaty matter is less oxidisable than animal matters under the same conditions.

During these experiments, it was observed that a considerable precipitation of brown peaty matter occurred when the strong bog drainage was mixed with a comparatively small bulk of distilled water. This precipitation, it was observed, promised to throw light upon the amelioration of peaty waters which had been remarked by Mr. Bateman and other engineers.

In criticising Dr. Tidy's experiments on oxidation, Dr. Frankland ("On the Spontaneous Oxidation of Organic Matter in Water," Loc. Cit., p. 538) remarks on the apparently superior action that Dr. Tidy attributes to air acting on running water, which is absent in the case of falling water, unless it falls naturally in a river bed. The influence which so favoured the oxidation of polluted water, running in rivers with numerous unpolluted affluents, appears always absent when the water is dashed into foam in a glass bottle, violently stirred up with glass rods, and especially when water is merely "exposed to light and air in a bottle."

Whether air has apparently a purifying action on river water, falling or running, superior to that exerted on water contained in a bottle, is a point which has not been proved by Dr. Tidy, though the means of proof are exceedingly simple. It appears to me, after a careful perusal of Dr. Tidy's paper, that all he has proved regarding the Shannon waters, is a decrease in peatiness during their onward flow. It is, therefore, an open question whether the self-purifying process is due to oxidation. Indeed, Dr. Tidy himself states that, in the case of peat, the quantity of organic matter is kept in check by the following means, which are two, namely:—

1. "The inherent power that water possesses of self-purification from the oxidation of the peat by the oxygen held in solution in the water. This process is enormously helped by certain natural and physical conditions, whereby the more complete aëration of the water, and the more intimate contact between oxygen and the peat, is effected."

2. "Mechanical precipitation by admixture with coarse mineral suspended matter. The artificial means of purifying peaty water are, storage, subsidence, and filtration."

We have, therefore, an alternative process of purification which is here termed "mechanical precipitation."

I am disposed to give every possible consideration to the question of oxidation, and am ready to allow that water exposed to air in a closed bottle, is always exposed to the same air, or, if the experiment be made in an open bottle, that it is not brought under the influence of fresh air except by the slow process of diffusion. Now, if it were proved that peaty matter in water was removed by aëration by *fresh air* and oxidation, we should be forced to the conclusion, sunlight being ineffectual, that the fresh air of the country contains some minute constituent, not present in sufficient quantity in the confined space of a bottle to make any perceptible difference in the water. Such an agent is ozone, which, in the atmosphere of the open country, never exceeds one

volume in 400,000 of air. Although I have examined this question, I do not propose to offer any analytical data as evidence whether atmospheric ozone can, or may, act as an oxidiser of the organic matter of flowing waters; the evidence at my disposal shows that it does not. I mention this matter to show the train of reasoning which led to the following investigation. In the meantime, I shall only remark here that running waters are subjected to agents other than atmospheric air, which may, and do, sometimes act as purifiers. They are in contact with the river bed, and the soil on its banks.

River waters, as is well-known, contain, besides peaty or other organic matter, certain mineral constituents, which are dissolved out of the river banks, or are the result of solvent action on the rocks which lie in the bed of the stream, or which compose the strata through which spring waters pass to feed the river. On the bed and the banks of the river, such solvent action may be expected to be most energetic where waters are dashed against the rocks in the act of precipitation over a fall. It, therefore, seems to me that the relation of the mineral constituents of streams to the self-purification of the water from organic matters, has scarcely been adequately studied by Dr. Tidy, notwithstanding his statements above quoted. I am led to this remark by certain observations of my own, made on different occasions during the last fourteen years.

In October, 1869, during a short residence in Ireland, I first observed that some peaty streams become rapidly decolourised, while others flow for considerable distances without undergoing any visible alteration.

In August, 1874, while staying in Invernesshire, I remarked the course of the River Affaric, which flows from Loch Affaric through Loch Benevian, to join the River Glass, a run of six miles over a hard rocky bed (quartzite, micaceous schist, and basalt). No alteration in the colour of the water was detected, for three weeks, while the observations though, were carried on, no rain fell, and there was abundance of sunshine. Several falls occur, and the stream is frequently lashed into foam along its course; it is, therefore, submitted to aëration in the fullest degree. This aëration is of the kind most likely to effect oxidation, the air being of the most highly oxygenated character, and charged with ozone. As the peaty colouration was not of a dark shade, any bleaching it could undergo would most certainly be noticeable. Nothing of the kind occurred, and although this "naked eye" inspection of the river was to my mind perfectly satisfactory evidence of the unaltered condition of the water, I do not wish it to be generally accepted as such. Certainly, nothing occurred resembling the bleaching process recorded by Dr. Tidy as having taken place at Doonass Falls, on the River Shannon, and the oxygenation of the water was not productive of any visible result.

My experiments on peaty waters in Ireland, in 1869, showed that a certain amount of colouring matter was separated when a certain spring water of 26° of hardness was mixed with a soft peaty water. Furthermore, that the purification was much more effectual when the mixture was softened by an addition of lime water, as the calcic carbonate which separated carried down nearly all the peaty matter. The decolourising power of aluminic sulphate was found to be such that two or three grains removed in twelve hours the whole of the peaty brown colour from ten gallons of water. From this result, it was thought that certain clays, when mixed with water, would have a similar effect, and experiment proved this anticipation to be correct.

Mr. J. Y. Buchanan, formerly of the scientific staff of H.M.S. *Challenger*, in his investigation of the waters of highland lochs, found that the bottom waters were generally perfectly clear and colourless, while on the surface, and for several fathoms below the surface, water was coloured with organic matter, and not always quite clear. When accompanying Mr. Buchanan in the steam yacht *Mallard* this fact was brought under my personal observation in Loch Ness, in places where the water is 50 to 110 fathoms deep, and the bottom consists of fine white or blue clay.

At the commencement of the year 1880, I felt that some information regarding the clearing of peaty streams would be valuable, and accordingly I placed my notes at the disposal of Mr. Gerard A. Kinahan, Associate of the Royal College of Science, Dublin, and advised him in the carrying out of this research in my laboratory.* I propose, therefore, to give in detail the methods of examination resorted to, together with the nature of the waters examined, the results obtained, and the conclusions arrived at; but, first, it may be advantageous if I define the propositions which are accepted. They are the following:—

1st. Aëration by agitation in bottles is not

* Report on the Clearing of Peaty Waters. Second series vol. iii. Proc. Roy. Irish Academy, pp. 447, 596.

effective in the purification of waters from organic matter. (Miss Lucy Halcrow and Dr. Frankland.)

2nd. Some peaty streams become clear in the course of their flow, while others do not.

It remains for us to examine evidence of oxidation, or of other action, on the organic matter of peaty waters caused by natural aëration, and to investigate the influence of the river bed upon flowing streams.

The Effect of Natural Aeration on Peaty Waters.

In consideration of this question, the evidence available may be gathered in two ways, namely, by the "naked eye" inspection of rivers, and by analytical data concerning the organic carbon and nitrogen in the water. Many most important observations were made on small streams, but those yielding unimpeachable evidence were made on two rivers situated in the County Wicklow, in the course of which occur two very considerable falls of 360 and 700 feet respectively. The first of these is the Dargle river, which is precipitated over a rocky mountain-side, forming the well-known and beautiful Powerscourt waterfall. In October, 1881, on a fine, bright, and warm day, samples of water were collected. There was a slight flood on the river, and the water was unusually peaty, as during the two preceding days rain had fallen upon the hills; but, nevertheless, the water was free from turbidity. The first sample was taken a short distance above the fall, where the river flows through a deep channel in the mica-schist. From this point the water is precipitated over the face of the rock in a thin layer, presenting a remarkably large surface to the air. It is frequently dashed against rocks, and distributed in the form of spray, collecting again into a steady stream at the termination of its descent. It is altogether surprising to see how small a quantity of water is presented on so large a surface of rock. At the foot of the fall, separated 800 feet horizontally, and 360 feet vertically from the channel before-mentioned, the second sample of water was collected. No visible drainage of any kind enters between these two points. The long range of mountains constituting the drainage area of the River Dargle, above the fall, is principally composed of granite, the mica-schist occurring only at a short distance from where the descent commences. Peaty matter is distributed over nearly the whole area. When the two samples were examined in the laboratory, in a vertical tube eighteen inches long, there was no visible difference between them. Both showed a clear dark-brown colour, with very little suspended matter, and deposited only a slight brown sediment after standing.

The analysis of these waters was made in the following manner:—A litre of each sample was evaporated down to 100 cc. in flasks, the complete expulsion of the water being accomplished in a glass dish, under a glass shade of the form employed by Dr. Frankland. All the precautions observed by Dittmar and Robinson were attended to, and the residue was burnt in a combustion tube open at both ends, the anterior portion of which was plugged with silver wire. In burning the residue in an open tube, the air necessary was very carefully purified by being collected in a glass gas-holder charged with diluted solution of caustic alkali. As it was discharged, it passed over caustic alkali, in sticks, through a soda-lime tube, and through two bottles containing oil of vitriol. The current of air was maintained as a steady stream by the pressure of six inches of water, glass taps being used to regulate the pressure.

It is important that no india-rubber joints be used except where absolutely necessary, the air being exposed as little as possible to the india-rubber. The water residue was removed from the basin by a platinum spatula, and the final portions were detached from the glass, by rubbing the surface with some granulated copper oxide. The water residue, after being transferred to a boat of platinum recently made red-hot, is covered with copper oxide previously ignited. The gases from the combustion, passing out of the tube, enter first a small U-tube containing a 50 per cent. solution of sulphuric acid saturated with chromic acid, then a small tube containing fused but porous calcium chloride, pounded into very small pieces, and sifted free from dust. The carbonic acid was collected in a soda-lime tube, the soda-lime being separated by a plug of glass wool from a layer of calcium chloride. These solid absorbent materials were all pounded and sifted, so as to pass through meshes of wire gauze with about 400 holes to the square inch, all dust being separated by a finer sieve. The weighings were made on a balance capable of turning easily with the 1-10th of a milligramme. The nitrogen was estimated by burning the water residue with soda-lime, sifted as before, in a copper boat, in a tube through which passed a

stream of perfectly pure hydrogen, incapable of giving any reaction showing presence of ammonia when passed through Nessler solution. It is important that the hydrogen be carefully tested, since it has been found to yield ammonia after very careful purification with solid and liquid reagents, capable of absorbing the alkali. The same supply of gas was found not to contain ammonia after it had been strongly heated in a glass tube. Of course, the presence of nitrogen oxides in the sulphuric acid would fully account for the formation of ammonia, by the action of nascent hydrogen disengaged in the apparatus, but it is scarcely conceivable that this could pass out of the acid liquid in which it would be formed. The apparatus, however, was of the form known as Kipp's, and if the action be rapid, and the gas accumulates in the central bulb, the zinc becomes almost dry. Under these circumstances, it is conceivable that ammonia might be carried off by the current of gas; but it is scarcely credible that it should pass uninterruptedly through a very efficient drying apparatus charged with oil of vitriol. In all cases precautions were taken to ascertain that no source of error should arise in this way, by making blank experiments previous to commencing the actual analytical operation. The analyses were made in duplicate, and in the weighings for the organic carbon the allowable error was taken as under three-tenths of a milligramme of carbon dioxide—or less than one part of carbon in ten millions of water. Nitrates and nitrites were estimated, the quantity was that merely occurring in rain-water; and as we are not concerned either with these constituents of the waters, or with chlorine and solids, I need not describe further the analytical process. The results obtained from the analyses of the water above and below the Dargle waterfall, are stated in the Table in the next column.

The proportions of organic carbon and organic nitrogen, under the circumstances of such effective aëration as a fall of 360 feet in a vertical direction, and for most of the distance in the form of spray, should undergo some alteration if oxidation is possible by aëration. The two constituents in the two samples show no further variation than may be fully accounted for by experimental error, namely, merely two parts of carbon and five parts of nitrogen in 100 million parts of the water.

The next water examined was that of the Carawaystick brook, which flows out of a small sheet of water called Kelly's Lough,

Analysis of Water from the Dargle River, above and below Powerscourt Waterfall. The Constituents are stated in parts per 100,000 of the Waters.

	Above the Fall.	Below the Fall.
Organic matter:—		
Carbon	0·946	0·944
Nitrogen	0·072	0·077
Ammonia	0·001	0·001
Nitrogen, as nitrates and nitrites	..	..
Total combined nitrogen	0·073	0·078
Chlorine	0·48	0·88
Total solid matter	4·20	4·40

Remarks.—Clear, but deeply coloured with peaty matter, October 1st, 1881.

situated on the south-eastern slope of Lugnaquilla, at an elevation of 1,700 feet above the sea. The descent of this stream is rapid, for in a flow of less than two miles the water runs at a level lower than Kelly's Lough by 1,200 feet. At one part of its course it is precipitated into the valley of Glenmalure, 700 feet below, falling over a bed of granite and schistose rock in a series of foaming cascades of nearly perpendicular descent, and exceedingly picturesque in appearance.

Aëration and agitation are here as complete as possible. In no part of its course is any diminution in the peaty brown tint of the water visible, though a most careful comparison was made of the waters above with those below the falls.

Samples of this water, collected both in summer and winter, were taken at a distance horizontally of 1,600 feet apart, the vertical height between the points being 700 feet. No side drainage enters with the fall, nor is the water submitted to any action or change of condition, other than complete aëration, which can possibly effect the organic constituents. In January, 1882, when the winter samples were bottled, there was a light mist on the hills, otherwise the day was fine and dry, but not cold. The waters were clear, and of a light olive brown tint. The samples collected in summer, August 15th, 1881, were deeply coloured with peaty matter. The streams are generally browner in summer than in winter, and in frosty weather they are often quite colourless. A Table, showing the results of these analyses, follows:—

ANALYSES OF WATER FROM THE CARAWAYSTICK RIVER ABOVE AND BELOW GLENMALURE FALLS.

IN 100,000 PARTS OF WATER.

	Organic matter.		Ammonia.	Nitrogen as nitrates & nitrites.	Total combined nitrogen.	Chlorine.	Total solids.	Remarks.
	Carbon.	Nitrogen.						
Samples collected in Winter.								
I. Above falls	0·284	0·022	..	0·004	0·026	..	..	Clear, but coloured with peat. Collected Jan. 7, 1882.
II. „ „	0·286	0·025	..	0·004	0·029	1·5	3·26	
III. Below falls	0·284	0·021	..	0·004	0·025	1·6	3·34	
IV. „ „	0·289	0·025	..	0·004	0·029	...	..	
Samples collected in Summer.								
V. Above falls	1·06	0·054	trace	..	0·054	1·30	..	Deeply coloured with peaty matter.
VI. Below falls	1·17	0·053	trace	..	0·053	1·4	..	
VII. From Kelly's Lough	0·68	0·054	trace	..	0·054	1·2	..	Rather peaty. Collected August 15, 1881.

The composition of the water above and below the falls is almost identical; there is no decrease in the amount of carbon and nitrogen, which shows that aëration of the most effective character has no effect of the slightest kind in decreasing the organic constituents. An analysis is added of the water from Kelly's Lough.

I consider the foregoing analyses conclusive evidence, that a peaty river water cannot undergo the slightest degree of purification from its organic constituents, by the natural process of aëration.

I now come to the consideration of the altered conditions in a river water, caused by the reception of a mineral matter of a more or less soluble character.

THE MECHANICAL ACTION OF INSOLUBLE MATTER IS DEVOID OF DECOLOURISING POWER.

It was found by experience that the depth of colour of peaty water was a fair indication of the quantity of organic matter present, and the following evidence is dependent on this fact:—

(1.) At the point where samples of water were taken out of the stream which flowed from Kelly's Loch, another series was collected under the following circumstances:—The first came out of the river at the foot of the falls, then at the head of the falls a quantity of sand clay, about a cubic yard in measurement, was thrown into the stream; just above this point the second sample was taken. The whole of the water was rendered very turbid. A descent was then made to where the first sample was taken. After waiting until the turbid water had flowed for some time, a third sample was taken. On comparing the colour of these waters, after the turbidity of the last had subsided, it was found that the first and second showed no difference in colour, while the third was the darkest.

The following materials were added in large proportions to peaty waters, and after thorough mixing by violent agitation in tall cylinders, the mixtures were allowed to subside. Any diminution in tint of the water was noted by comparison with the original sample.

(2.) A pure quartzose sand, even when added in large quantities to the water, had no perceptible action on its colouring matter.

(3.) Pure gelatinous silica, which acts to some extent as a mordant of aniline dyes, was quite without effect.

(4.) Magnesia was without action.

(5.) Pure carbonate of lime has only a very slight action on the peaty colouring matter.

(6.) Powdered chalk and limestone were found to reduce the tint slightly.

(7.) Clay of different kinds, which had been treated with a 7 per cent. solution of hydrochloric acid, so as to dissolve out the soluble matter, was found to have only a very slight decolourising power.

The results of the experiments described as Nos. 1, 2, 3 and 4, prove that there is no decolourising action on the peaty colouring matter which can be described as *mechanical*. Pure carbonate of lime, powdered chalk, and limestone, are slightly soluble in water, and it is a chemical action of these substances

which reduces the peaty tint. The action of the insoluble constituents of clay appears likewise to be due to the iron and alumina they contain, to which the peat colouring matter attaches itself as to a mordant.

The Agents Operating in the Self-Purification of River Waters.

The decolourisation of peaty streams by mine drainage.—The Carawaystick brook, running down into Glanmalure, joins the Avonbeg. This river, uniting with the Avonmore at the "meeting of the waters," forms the Avoca River. The changes which occur in the Avonbeg are irregular; but there is, in general, a diminution of the peaty tint.

The Avoca River, however, in the course of its flow, soon receives on its east bank waters from the mines of Tigroney, Cronebane, and Connary, which waters contribute to the streams ferrous sulphate and alumina sulphate in comparatively large quantities, while smaller proportions of such substances as copper sulphate, and arsenic, are found therein. On the west bank of the river, but lower down, are the Ballymurtagh and Ballygahan mines. A sample of water, taken at the tail of the landers, at Ballygahan, there were found 56·8 grains of ferrous sulphate, and 54·7 of alumina sulphate per gallon. This water is capable of removing, in a most complete manner, the colouring matter from fifty times its volume of very peaty water. A dark brown precipitate first settles, and then a deposit of ochre occurs.

The small tributaries of the Avoca River contain considerable quantities of dissolved mineral matter, as shown by the following analyses:—

Analyses of the Waters of the small Tributaries of the Avoca.

	Parts per 100,000 of the water.	Remarks.
"Red Road" Stream.	Ferric oxide, Alumina .. 3·8; Copper ....0·05	Colourless, slightly acid, ochre in suspension.
Tuniahinch Stream.	Ferric oxide, Alumina .. 4·8; Copper .... 0·02; Total solids 12·8	Colourless, slightly acid, brown sediment.

A sample of slightly turbid but very peaty water, taken from the Avoca River, below Ballygahan mines, deposited a brown precipitate after being at rest for some time, and the colouring matter was much reduced. On another occasion, the tint of the water was not so deep, and after settling, the colour was quite removed. The precipitation of the peaty matter is followed by a deposit of ochre.

When a few drops of a solution of ferrous sulphate are added to a quantity of peaty water, a peculiar turbidity is the result, this afterwards increases to a brown precipitate, which collects at the bottom of the vessel, the water being free from peaty colouring matter.

It is very noticeable, in the Avoca River, that the stones are covered with an ochreous deposit, and that ferruginous matter is deposited in the pools. It appears that the ferrous salt in solution carries down the organic matter at the time it is oxidised, for this is the action observed when a pure solution of ferrous sulphate is added to peaty water.

Samples of water were collected on the 16th January, 1882, at Tigroney Weir and Black Dog; between these points, the Avoca River falls only fifty feet in a flow of three miles, and therefore aëration, which, *per se*, has been shown to be without action on the organic matter in the waters of the Carawaystick Brook and the Dargle River is certainly inoperative in this case.

The subjoined analyses of these samples show that with the increase in the mineral matter there is a decrease in the organic matter held in solution:—

The effect of low temperature on dissolved peaty matter.—Mr. G. A. Kinahan remarked that, when there was a considerable quantity of snow on the hills forming the drainage area of the tributaries of the Avoca River, the peaty colour of the waters was diminished much below that of ordinary occasions, and, indeed, the waters frequently were quite colourless. Mountain streams presented the greatest difference in appearance in frosty weather; some which were usually deep brown in colour became perfectly clear and free from colour during frost.

When peaty water is frozen in tall cylinders, a layer of deeply-coloured water collects at the bottom, and the water resulting from the thawing of the ice is quite free from colour. If the freezing takes place from the sides of the vessels, a core of peaty water collects in the centre. When freezing occurs with great rapidity, a mass of clear ice is formed, in which are liquid enclosures of concentrated peaty water.

When freezing proceeds in a cylinder from

ANALYSES OF WATER FROM THE AVOCA RIVER, BEFORE AND AFTER RECEIVING MINE DRAINAGE.

PARTS PER 100,000 OF WATER.

	Organic matter.		Ammonia.	Nitrogen as nitrates & nitrites.	Total combined nitrogen.	Chlorine.	Total solids.	Remarks.
	Carbon.	Nitrogen.						
I. At Tigroney Weir....	0·231	0·026	trace	0·011	0·037	1·8	4·88	Slightly peaty.
II. „ „	0·229	0·028	trace	..	0·039	..	..	
III. At Black Dog	0·098	0·019	trace	0·008	0·027	2·3	9·26	Colourless.
IV. „ „	0·093	0·019	trace	..	0·027	..	..	A trace of iron present. Collected Jan. 16, 1882.

above downwards, a clear and colourless block of ice may be removed, and a layer of deeply coloured water is left at the bottom. Repeatedly filling up with peaty water, and again freezing, causes the formation of a very small quantity of a brown sediment. It does not appear from this that freezing causes a precipitation of peaty colouring matter in an insoluble form, though it does cause a purification of the water frozen, and a concentration of the peat solution. As, however, it was the water and not the ice of the streams which was under observation, there must be some other cause for its greater purity during frost.

Mr. Kinahan explains it in the following manner:—In frosty weather the surface of the bogs is frozen, preventing the percolation of waters which thus run away clear; and the water supply is often derived from melting snows, which are, therefore, uncontaminated. Thus, in one case, it was noticed that though a quantity of peaty water had collected behind a snow-drift, yet the water flowing from the other side of the drift was quite colourless.

ON THE CHEMICAL ACTION OF CLAYS, OR THE MINERAL CONSTITUENTS OF SOILS, IN PURIFICATION OF RIVER WATER.

From my opening remarks, my views, as to the action of clays in the self-purification of river waters may be gathered. In order to ascertain how far the mountain streams of the county Wicklow are actually, or may possibly be, purified from organic matter by the chemical action of the clay in the bed or on the banks, specimen of clays and disintegrating argillaceous rocks were collected for examination.

Experiments were made by shaking up weighed quantities of the clays with carefully measured volumes of water, contained in tall cylinders. When the water had become clear, a large portion was decanted or syphoned off, and placed in another cylinder, for comparison with the colour of an equal volume of the original water. By this treatment, it was found that, provided only a sufficient quantity of the clay was used, any peaty water could be decolourised.

I will now give the description and the analysis of the clays collected by Mr. Kinahan, together with an account of their action.

No. 1.—A fine cream coloured clay, containing fragments of iron pyrites and milk quartz, was found to be a most efficient purifier. When added to peaty water, the greater portion settled down almost immediately, but the very fine particles remained in suspension for some time. Complete subsidence left the water very clear and colourless, when sufficient clay had been used; the sediment was covered with a brown layer, as if the colouring matter was there deposited. With a litre of dark peaty water, 4 grammes of clay rendered the water clear and colourless; 2·5 grammes caused destruction of the colour, accompanied by persistent turbidity, which was not apparently decreased by filtration; 1·5 grammes changed the brown colour to olive green.

The clay was shaken up with water, in the proportion of 10 grammes of the former to 300 cc. of the latter; the liquid was filtered, and the filtrate was found to possess the property of decolourising peaty water. The clear solution has an acid reaction, and contains a small quantity of ferrous and alumina sulphates. The insoluble portion of the clay was digested with hydrochloric acid, and well

washed. It action as peaty water was scarcely perceptible after this treatment.

Its composition was as follows :—

Analysis.	Per cent.
Insoluble in hydrochloric acid	92·51
Ferric oxide	2·35
Alumina	2·43

No. 2.—A disintegrated steatic shale of a light yellowish red colour. It yields, on treatment with water, a turbid yellowish liquid, which clears on standing, the suspended particles subsiding; the resulting clear liquid, which is neutral to test paper, contains very little dissolved matter. Only a very minute inorganic residue is left after digesting 5·5 grammes of the clay with water, filtering and evaporating the filtrate to dryness.

Its composition :—

Analysis.	Per cent.
Insoluble matter	78·28
Ferric oxide	8·12
Alumina	7·96
Manganese	trace

In a litre of water, 25 grammes caused perfect purification. Insufficient additions of the clay caused a persistent turbidity, or an olive green colour, as in the previous case.

No. 3.—A bluish clay occurring in a cliff on the Ballynagappoge brook. When added to a brown peaty water, it removes all but the green tint, and leaves a slight turbidity. It forms a dirty turbid liquid when mixed with clear and colourless water, and a peculiar turbidity to some extent remains after the liquid has been left some time for subsidence to take place. This turbidity, which resembles that of imperfectly-purified peaty waters, is found to be removed by an addition of a small quantity of a red clay about to be described:—

Analysis.	Per cent.
Insoluble portion	81·79
Ferric oxide	6·72
Alumina	6·47

No. 4.—A brick-red clay from one of the tributaries of the Mucklagh brook. With pure water, this clay yields a perfectly clear solution after the fine particles have subsided. From a litre of water, 20 grammes of clay removed all the peaty matter. It is very efficient in purifying action, but insufficient quantities of the material cause the before-mentioned changes in the water, from brown to olive-green, or else a turbidity which, from the colour of the clay, makes the water appear of a red colour.

Analysis.	Per cent.
Insoluble matter	72·41
Ferric oxide	9·70
Alumina	9·41

Mr. Kinahan has remarked that the blue clay, No. 3, seems to have been originally a red clay like No. 4; its present condition being due to percolating peaty waters. I will quote what he says on the matter :—

"1st. A similar blue clay overlies No. 4, as seen in the banks along the Mucklagh brook, the passage from one to the other being gradual; red stones and particles of red clay are seen occurring in this overlying clay.

"2nd. The residues left by both specimens, after digestion in hydrochloric acid, are alike.

"3rd. The per-centage of insoluble matter in No. 3 is greater than in No. 4, the more soluble portions, iron and alumina, having been probably removed by percolating waters."

No. 5. A whitish sandy clay from the banks of the Carawaystick brook, where it occurs in an ancient moraine above the falls. It was this material which was thrown into the stream above the falls, and found to have no perceptible action as a decolouriser. In the laboratory this result was confirmed; even when added in very large quantities, it produced very little alteration in the colour of peaty water.

Analysis	Per cent.
Insoluble matter	93·91
Ferric oxide	1·63
Alumina	2·17

No. 6.—A disintegrating granite, from Aughavannagh, county Wicklow, a rock which underlies the peat of the district. Its constituent minerals are quartz, black and white mica, and felspar, passing into china clay. This specimen acts very slowly, the impurities in the water settle out in a layer after the mineral has been shaken up with the water, and repeated shaking causes a marked reduction in colour. The felspar, which is a very hard variety containing very little iron, acts in the same way. It was noticed that the layer of water lying next the mineral for some time in a glass cylinder, was less coloured than that above.

Analysis	Per cent.
Insoluble matter	86·68
Ferric oxide	3·80
Alumina	6·24

The turbidity which is mentioned as occurring after the peat-colouring matter is removed, is due to the pedetic motion of the fine

clay particles. Such turbidity is at once removed by an addition of saline matter in solution, as, for instance, common salt, or sea water, or, as is shown here, by an excess of clay. (For further particulars regarding this clay turbidity, see the *Quarterly Journal of Science*, April, 1878, vol. viii., "On the Movement of Microscopic Particles Suspended in Liquids," by Prof. W. Stanley Jevons, F.R.S.; also in connexion with this subject, "An Explanation of the 'Brownian' Movement," W. N. Hartley, *Monthly Microscopical Journal*, June, 1877.)

The Action of Metallic Hydroxides and Oxides.

It was thought desirable to ascertain the action of commonly occurring forms of metallic oxides as purifiers of peaty water, the method of testing being the same as that carried out with the clays.

The colouring matter of peat was rapidly and efficiently precipated by aluminic hydroxide, ferric hydroxide, and manganic hydroxide. Alumina is by far the most active, the iron compound coming next. The oxides of these metals were much less rapid in their action. Only after repeated shaking with the water did the manganese dioxide and ferric oxide produce any perceptible alteration in tint.

Aluminic hydroxide was mixed with water, and the solution filtered. The filtered liquid caused precipitation of the colouring matter from peaty water. Hydroxides of iron and manganese, submitted to the same treatment, yield solutions which are quite inactive.

The Action of the Clay in the Bed and Banks of a Stream upon the Water which flows against it.

As an evidence of the active nature of a river's banks as a means of purifying the waters, a careful observation, made by Mr. G. A. Kinahan, has shown that the "Ballynagappoge brook, the head waters of which are deep brown, and the feeders of which are equally peaty, is purified to a great extent by the blue clay, No. 3, which forms a cliff on the banks of the stream, and against which the waters wash and remove therefrom a considerable quantity of the mineral." Clay No. 3 has been proved to be a most efficient purifier, and after contact of the waters therewith, the stream is seen to be very slowly but steadily reduced in colour. The waters fall about 500 feet in a distance of a mile and a-half, the stream flowing rapidly in a succession of little falls; at about five hundred yards above Rosahane bridge, the rate of fall is diminished, and the rocky bed is changed to one of clay and gravel. The peaty matter is here reduced to a mere trace. Just above the bridge, where the fall is slight, there are several marshy places from which iron stained waters flow into the brook, and below the bridge the water is completely decolourised. The ferrous carbonate contained in the waters from the marshy land, yields ochreous precipitations of peaty matter, and renders the water most beautifully clear and colourless. The ferrous salt is produced by the action of water and decomposing organic matter upon the iron compounds in the clays and gravel. The deposits of ochre on the stones and in the pools of the streams, resemble those caused by the mine drainage waters discharged into the Avoca River. This is a true case of the self-purification of a river water by the action of the mineral constituents contained in its bed and banks.

From a number of experiments made on peaty colouring matter in water, I conclude that it acts like an organic acid, and that it is probably a body of the type of alizarine or litmus, being only slightly soluble, or even insoluble, in pure water, but readily dissolved in water containing traces of alkali, or of soluble carbonate, such as ammonia or potash. With metallic oxides, iron and alumina, it forms insoluble compounds of the nature of "lakes." Limewater also precipitates it. Mineral acids, sulphuric, hydrochloric, and nitric, precipitate it. Peaty water may be perfectly bright, and free from turbidity. These facts, and a further observation that subsidence will not clear a peaty water of its colouring matter, lead to the conclusion that the colouring matter is held in solution, and precipitated as a lake, by various mineral bases.

On Dr. Tidy's Conclusions as to Natural Oxidation of Peaty Matter.

On page 295 of the Chemical Society's *Journal*, vol. xxxvii., appears the following passage ("Tidy on River Water"):—

"I have had opportunities, during a fortnight's inspection professionally, of studying this subject in that most wonderful of great rivers, the Shannon, along a run of very nearly fifty miles (from Portumna to Limerick), the river receiving, throughout the whole course examined, not only feeders containing—except in one or two cases—an even larger quantity of peat than itself, but the drainage, of a deep coffee

tint, and in not inconsiderable streams, from huge bogs covering many square miles of country. I am aware that I am now entering upon a subject where great differences of opinion exist, and I would approach it cautiously.

"Let me, then, put the case of the Shannon below Portumna, containing a quantity of peat represented by 0·9 of organic carbon per 100,000 (for in arguing this question of oxidation I shall, in the main, appeal for manifest reasons to the indications of the combustion process), receiving, as it continues to flow, an enormous quantity of black peaty matter, and streams much more peaty than itself, and drainage from an area that can only be described truly as a peat bog. Should we not expect, I ask, if the water contained in itself no inherent power of purification (I mean, of course, the power of effecting oxidation of the peat), that a sample examined thirty-five miles further down the river, say at Castle Connell, would contain an enormously increased quantity of matter? But the reverse of this is the case. For not only does the two-foot tube tell that the peat is manifestly less, but on analysis the organic carbon at Castle Connell is found to be only a little over one-half what it was at Portumna. What then has become of it? Certain it is the peat could not have evaporated, and I confess I can invent no possible explanation of its disappearance except by believing that, in the course of its flow, it has been oxidised by the oxygen held in solution by the water. At any rate, those who hold non-oxidation in running water must explain how it is that the absolute organic carbon, by a flow of thirty-five miles (even in the face of the fact that the river in the course of its flow is receiving enormous volumes of highly peat-charged water) is lessened in so remarkable degree."

Samples of water were taken from either ends of Lough Derg, through which the Shannon flows; the length of the lough is twenty-five miles. The difference in the organic carbon of these two samples was only 0·18 parts per 100,000.

"A third sample was taken one mile below Killaloe. As a matter of fact, there is less bog drainage going into the river in this short run than at any other spot in the fifty mile flow examined, although even here the quantity that finds its way into the river is not inconsiderable. Nevertheless, in the course of this one mile flow, the organic carbon fell from 0·8 to 0·48. Incidentally, I may mention, that these results were confirmed by the oxygen process, and by the appearance of the water in the two-foot tube. From this point, to within half-a-mile from Castle Connell, the quantity of peat drainage that enters the river is enormous; indeed, an extensive peat bog, covering miles of country, pours into the river its absolutely black drainage water in full-sized streams. At O'Brien's-bridge, the organic carbon was found again to have risen to 0·84 per 100,000, and I have no doubt, from the two-foot tube observations, although I have no analysis in proof, that below this spot the quantity of organic carbon would have been even greater. This highly peaty water, after a very short run indeed, although (and I must again insist on this point) here and there receiving notable quantities of bog drainage, becomes very manifestly less peaty, the organic carbon being reduced from 0·84 to 0·593 per 100,000 parts.

"How can this remarkable result be accounted for? Thus, between the two points where these samples were taken, are to be found the far-famed falls of Castle Connell, where, in the course of a few hundred yards, the level of the river sinks fifty feet. The extent of aëration the water must undergo in these magnificent falls must be considerable. The part they play in effecting the purification of the water is strikingly manifest, in comparing the dark tint of the water as it foamed and bubbled over the rocks with which it first came into contact in the upper part of the Doonas Falls, with the comparatively light peaty tint the water exhibited as it played over the rocks situated at the lower parts of the falls. I watched these changes of tint for some hours along the course of the falls, and a more magnificient natural experiment I never witnessed. If this alteration in actual quantity, as shown by analysis, is not oxidation, I am totally at a loss to conceive what it can be."

I have quoted Dr. Tidy's own written words, in order that I may not in any way misrepresent his opinions, or the nature of the evidence upon which he founds his doctrine of the oxidation of peaty matter in running water. The organic carbon at Castle Connell was found to be only one-half what it was at Portumna, thirty-five miles further down the Shannon. Let me draw attention to the following words:—

"Certain it is the peat could not have evaporated, and I confess I can invent no possible explanation of its disappearance except by believing that, in the course of its flow, it has been oxidised by the oxygen held in solution by the water."

It will be remembered that, at Castle Connell, the river sinks a trifle of 50 feet in the course of a few hundred yards, and the water collected by Dr. Tidy below the falls contained less organic carbon than that collected above. "If this alteration in actual quantity, as shown by analysis, is not oxidation, I am totally at a loss to conceive what it can be." Shortly afterwards, we are told, p. 300—

"These, then, in the case of peat, are the natural means whereby the quantity in running water is kept in check.

"1. The inherent power that water possesses of

self-purification from the oxidation of the peat by the oxygen held in solution in the water."

I have already shown that the most complete aëration, effected by a descent over falls 360 and 700 feet in height (not a mere 50 feet), is quite without action—that there is no oxidation of the peaty matter. The evidence is directly contradictory to the above positive statement.

How then are we to account for the diminution in organic carbon, as traced in the flow of these peaty streams? The question admits of a very simple explanation. Mr. G. A. Kinahan visited the Doonass Fall on the Shannon, at my desire, and collected samples of water, on both sides of the river, above and below the falls. His analyses showed that there was a greater difference between the two samples from opposite banks, above the falls, than between either of these samples and those taken below the falls. Moreover, the organic carbon was found to be increased in quantity in the samples collected after the water had descended the falls.

A few bottles full of water taken out of a very large river, here and there, are not average samples of the whole water in the river, even when the greatest care is exercised in collecting the samples.

The following remarks from Mr. G. H. Kinahan, of the Geological Survey, who lived for many years on the banks of the Shannon, in the neighbourhood of Doonass Falls, and for part of the time at Castle Connell, warrant this statement; and, at the same time, fully account for the discrepancies in the results obtained by Dr. Tidy and Mr. Gerard A. Kinahan.

"In the Shannon, between Killaloe and Castle Connell, the flood waters from the counties of Tipperary and Limerick, on the south-east and south, are 'black floods' (peaty water), especially those that flow into it between O'Brien's-bridge and Castle Connell; while the flood waters from the Clare side, to the north and north-west, except the stream from O'Brien's-bridge bog, are 'red flood,' highly charged with the red muds from the *débris* of the red basal carboniferous shales. These different classes of flood may differently affect the water at the fall of Doonass. If rain falls only in the counties of Tipperary and Limerick, there will be a 'black flood' over the falls, while, if the rain falls only in the county Clare, it will be a 'red flood;' but if the rain is falling on both sides the Shannon, the results will be very different. If, during such a rainfall, you stand at the World's End weir, Castle Connell, the flood on the Limerick side will be black, and that on the Clare side, red, the two differently-coloured waters going separately over the weir, to be slightly mixed below; but the great mixing does not take place until they reach the Falls of Doonass, below which the red ferriferous waters are found to have cleared out the peaty colouring matter. The waters flowing over the falls are more often coloured with peat than otherwise. While living at Castle Connell, some of the largest floods I saw on the falls were black ones. When the rain falls only to the southward of the Shannon, the 'black flood,' going over the fall is met by a 'red flood' coming out of the Annacotty, or Mulkear River, which neutralises and destroys the peaty colour in the water before it reaches Limerick. On account of the land on each side of the Shannon, above Castle Connell, the waters on each side of the river above the falls must give very different analyses."

These remarks are in accordance with the observations made on the clearing of the peaty rivers of the county Wicklow by the action of clays and soluble mineral matters.

The analyses of the waters collected immediately above and below Doonass Falls are the following:—

ANALYSES OF WATER FROM THE RIVER SHANNON. THE SAMPLES WERE COLLECTED FROM THE RIGHT AND LEFT BANKS, ABOVE AND BELOW DOONASS FELLS.

PARTS PER 100,000 OF WATER.

	Organic matter.		Ammonia.	Nitrogen as nitrates & nitrites.	Total combined nitrogen.	Chlorine.	Remarks.
	Carbon.	Nitrogen.					
Above Falls.							
I. From right bank	1·036	0·053	0·004	trace	0·057	1·75	Slightly peaty and coloured with suspended matter. Collected July 16th and 18th, 1881.
II. From left bank	0·818	0·040	0·002	trace	0·042	1·70	
Below Falls.							
III. From right bank	1·063	0·049	0·002	trace	0·050	1·87	
IV. From left bank	1·090	0·045	0·001	trace	0·046	1·87	

Dr. Tidy's results, which I conjecture were obtained from an examination of the waters on the Limerick side of the river only, above the falls, may be easily reconciled with the fact that the lessening of organic matter is not caused by oxidation. When we consider that the ferruginous mineral matter, free from bog waters, is discharged on the Clare side, that when mingling with the bog drainage it precipitates the peat, that these waters when flowing on a level must, to some extent, mingle, but when descending falls must be more or less mixed, then the phenomenon witnessed at Doonass Falls is capable of easy explanation. It is nothing more than the mixing of two waters, followed by a precipitation of organic matter contained in one of them.

I have here made no allusion to the question of oxidation in sewage-polluted streams; that has already been treated of by Dr. Frankland. He shows that a flow of between eleven and thirteen miles of a polluted stream has very little effect on the organic matter dissolved in the water, even at a temperature of 18° C. And he has shown that the case of the River Wear, flowing between Bishop Auckland and Durham, which has been quoted by Dr. Tidy in illustration of his theory of oxidation of sewage, the purification is caused by an admixture of highly ferruginous waters, a fact which does not appear in Dr. Tidy's quotation. I have felt it desirable that facts concerning the possible oxidation of peaty matter in water by natural means should be laid before the Society, and that the cause of the amelioration of such water, which has been not unfrequently observed, should at least receive some explanation in harmony with all hitherto ascertained facts.

DISCUSSION.

The CHAIRMAN, in inviting discussion, remarked that the paper was confined to the self-purification of peaty waters, and it would be well, therefore, not to travel beyond that subject.

Dr. VOELCKER said he felt personally indebted to Professor Hartley for the facts he had brought forward, inasmuch as they fully confirmed the view he had long entertained. At least thirty years ago he had worked with Professor Mulder on the humic acid series, and found it exceedingly difficult to effect oxidation of humic or ulmic acid. The view he had long entertained was that the removal of peaty matter from water was due to a separation of these organic acids of the humic series by mineral matters, especially basic iron salts, aluminic salts, and, in a minor degree, by lime salts. The colour of peaty water was due sometimes to very small quantities of acids in combination with either ammonia soda or potash; these alkaline ulmates and humates were soluable in water, and gave an intensely brown colour if the quantity of acid were at all considerable. The ammonia compounds were easily decomposed, and very frequently in waters which were not very brown, but distinctly yellow, organic acids were in combination with ammonia. These compounds were easily decomposed, sometimes by the new addition of a large quantity of water, as Dr. Frankland had shown; the brown coloured humic acids being precipitated. If he were asked to name a solution which was perfectly neutral when cold, and gave off ammonia on boiling, and yet remained neutral on cooling, he should say, try the experiment of extracting some rotten farmyard manure with water; when cold it would be perfectly neutral, but, on boiling, the ammonia would fly off, and a precipitation of brown coloured humic acids would take place, and the clear liquid was neutral. He mentioned this to show that it was possible to have peaty waters very little coloured, and containing more saline ammonia than many other waters; it also explained possibly the larger proportion of ammonia in peaty waters than in most other potable waters. He was glad the Chairman had confined the discussion to the question of peaty waters; and he must be allowed to utter a caution not to apply the remarks made in the paper to the self-purification of ordinary rivers, polluted with sewage. There were great differences in the facility with which various organic matters were oxidised; some oxidised so rapidly that you could not lay hold of them, whilst others were very difficult to oxidise or burn away; even with oxide of copper they could not be burned completely without the aid of a stream of oxygen or of chlorate of potash, or some similar powerful oxidising agent. The question of self-purification of ordinary river waters had been carefully avoided in the paper. It was unfortunate that Dr. Tidy had used an illustration which was not strictly accurate, when he referred to the self-purification of peaty waters as an act of oxidation; whereas he himself fully agreed with Professor Hartley that the change was mainly due to the intervention of mineral matters. On the other hand, it was also unfortunate that experiments on oxidation should have been made with a substance, the very last that he should have chosen, if he wished to ascertain whether objectionable matter in river water was removed by oxidation. Of all these objectionable matters, there was hardly anything so stable and persistent in character as peat. It would be only going one step further to shake up lignite, or even powdered carbon or coke, with air and water, and see what amount of oxidation you would get. Certainly, if he wanted to show something which did

not take place, he should choose the oxidation of peat; this, however, proved nothing as to the self-purification of ordinary polluted river water.

Professor CORFIELD concurred in the views just expressed. He should like to ask Professor Hartley if it had occurred to him that the large amount of evaporation which must take place in the summer, as the water went over the falls, might not account for the concentration of the water to some extent; and whether he did not prove too much in showing that the organic nitrogen and carbon were not reduced, and even in some cases increased; whether such apparent increase might not be due, especially in the case of chlorine, to the actual concentration of the water by evaporation. This took place in water flowing over land, especially in the summer, as sewage water sometimes passed off at the other side of a field more concentrated, as regards several constituents, than when it came on.

Mr. HOMERSHAM said it was quite correct, as stated by Mr. Hartley, that peaty water, at a warm temperature, held in solution a greater quantity of peat than when cold. In 1847, he had occasion to have some very exact experiments made on this subject, by the late Professor Ronalds and the late Mr. George Newport, F.R.S.* The results were as follows:—Water, from 57° to 65°, held peat in solution to the extent of about five grains per gallon; when the temperature was increased from 55° to 67° it held something like 7¾ grains; and when it was increased to 84°, there was as much as 14 grains. This was ascertained with water and peat from the Manchester water-works drainage ground, the peat, in many places, being 16 feet thick. Professor Hartley had treated the subject purely from a chemical point of view, but those who had practical experience of peaty water, and other water collected in large reservoirs, knew that something else had to be taken into consideration. There was the biological aspect of the question. You could not take a slow stream, running even a short distance in warm seasons, without getting a variety of living organisms in the water, first vegetable and then animal; these tended to work a marked effect on the colour of the water. If you took water such as that from Loch Katrine, or the large impounding reservoirs that supplied Manchester, you would find twenty or thirty different sorts of organisms, vegetable, animal, and diatomaceæ in a gallon. If he had been seeking a title for the paper he should have called it, on the self-pollution of river waters, for he knew of no river where the water at its source was not much purer than it was lower down. In the spring, blossoms, and in the autumn, leaves, unavoidably fell into it, besides other foul matter, and thus the water became impure the further it flowed. Even in districts where peat lay heavily on the ground, you often got springs issuing from the sides of the hills of a most pure character, perfectly free from organic, and almost free from mineral impurity, but when that water was conducted through closed pipes, and was impounded in spring water lodges for bleaching purposes, vegetable organisms soon pervaded the water. He had seen very pure water at the head of a stream in dry weather, which in a very short run was filled with large quantities of very fine weed, so much so, that in warm weather it took a man every three or four miles to clear it out. The weed grew rapidly, and it decayed almost as rapidly. As soon as it decayed, small animal life appeared in the water preying upon it. He knew of no river or spring water exposed to the air which did not get, more or less, polluted in this way.

** Results of Prof. Ronalds and Mr. George Newport's analyses, showing the quantities of saline and organic matter, &c., taken in solution by water mixed with peat for stated lengths of time, and at stated temperatures.*

Name of Water.	Temperature. Air. Degrees Fahr.	Temperature. Water. Degrees Fahr.	Date of Experiment.	Degrees of Hardness. Clark's scale. Distilled Water. 1·4 measure.	Degrees.	Quantity of matter in solution. Per gallon. Total in grains.	Organic matter.	Saline matter.	Longdendale District, east of Manchester.
Crowden Brook water with peat 24 hours.	58 to 60	57to65	1847 May 12 to 13	5·5	1·7	9·900	4·600	5·300	Peat from below heather cut from the ascent to Baream Moss, April 10, 1847. Temperature of atmosphere about 36° F. Specimens used in experiment taken at depth of four inches below the surface.
Ditto with peat 48 hours.	57·5 „ 70	57„63	„ 12 „ 14	9·0	3·0	11·250	5·200	6·050	
Ditto with moss peat 24 hours.	58 „ 74	58„67	„ 17 „ 18	10·8	4·33	15·180	6·550	8·750	Peat taken at one foot below the surface of Slidden Moss, May 13, 1847, about midday, when the temperature was at from 51° to 52° F.
Ditto with moss peat 48 hours.	58 „ 74	58„67	„ 17 „ 19	9·3	3·2	17·300	8·900	8·400	
Ditto with heath peat at 48 hours	59 „ 63	59„84	„ 12	„	„	24·700	14·600	10·000	Peat from below heather, taken April 10, as above.

Dr. PERCY FRANKLAND said the results obtained by Professsor Hartley entirely confirmed those obtained on a small scale by his father and Miss Halcrow, though several objections were urged to them at the time. Mr. Hartley, however, had shown that oxidation of peaty matter took place no more rapidly when water fell over a weir or a waterfall, than when it was shaken up in a bottle.

Mr. WARINGTON thought it would be found, in Professor Way's earliest paper on the absorptive power of soils, that clay would decolourise an aqueous solution brown in colour from the presence of organic matter. He found that such solutions, when filtered through clay, or when clay was added to them in sufficient quantities, were decolourised. There was no doubt Mr. Hartley had pointed out what was the real process in nature by which these colouring matters were discharged from peaty water. Professor Detmer, who had worked a good deal on humic acid, had come to the conclusion that it was a colloid body, and this enabled one to understand better how it might be carried down in a pseudo-mechanical way by precipitants. Hardly any soil could be taken, if it contained clay, which would not be found perfectly efficient in removing the colouring matter from water contaminated with peat. But if they came to the conclusion that peat was not oxidised in water by aëration, it did not necessarily follow as a corollary, that this non-oxidation was due to the fact that peat was a vegetable substance. It had been too hastily concluded by some that vegetable nitrogenous substances did not nitrify, whereas animal nitrogenous substances did so readily. Although some vegetable substances were hard to be attacked by oxidising agents, whether by organisms, or by the oxygen of the air, yet all were not alike, some being easily oxidised. If they wished to know what substances were capable of being destroyed in a river, they had simply to inquire whether they were capable of supporting the life of bacteria, or of affording food to plants; if so, they would, under favourable circumstances, be destroyed.

Mr. DE RANCE said he should like to offer a remark in confirmation of the views of his colleague, Mr. G. H. Kinahan. It was noticeable in the English Lake District, where the tops of the hills were covered with peat, and the water very brown, that when it came in contact with the refuse from the mines, it soon became colourless. It was worthy of note, also, that in areas where, from the nature of the strata, the water was of some hardness, from the presence of chemical constituents, it was far less peat-stained than in soft-water districts. It was only in areas like portions of Lancashire and Cornwall, where the strata were millstone or granitic, yielding soft waters, that you got those deep amber coloured waters which painters were so fond of delineating. This no doubt was of some importance in a chemical point of view, but being a geologist, he was not prepared to discuss it. With regard to the differences observed in summer and winter, he might remark that the sources of these rivers were generally at a considerable elevation, where the temperature was low in winter; and, in fact, last autumn, when engaged on the geological survey of Yorkshire, he had found the frost so hard, that he could walk in safety on what, in the summer, would have been an impassable quagmire; and the snow, which was then lying on the ground, being melted by the sun, ran off comparatively pure. In summer, again, there were dry times when the peat rotted away, and a heavy thunder shower would carry down large quantities of it; but in winter, when the wet weather was more continuous, most of the peaty matter would be carried down the first day or two, and afterwards the water would be comparatively pure.

Mr. STOKER remarked that sulphate of alumina was used for decolourising other organic substances; for instance, it was used in laboratories for decolourising caramel.

Mr. R. B. WHITE said indigo, annatto, and other colouring matters were precipitated from water by lime, the process being well known to practical dyers. In the Cordilleras and the Andes there were large areas of peat bogs, and the rivers descended not a few hundred, but six or seven thousand feet, before they reached the plains, and, as they did not lose their colour in the descent, the observations of Professor Hartley were well borne out. But after they reached the plains, and their waters mingled with other rivers containing large quantities of alluvial matter in suspension, the water became comparatively clear, and much more drinkable. The natives of those countries were quite aware that those waters which appeared a little turbid were more wholesome than the clear but dark coloured waters from the hills.

Mr. HARTLEY, in reply, said the amount of evaporation in one of the experiments could have been next to nothing, the air being saturated with moisture at the time. A slight effect might in some cases be produced from this cause. With regard to the biological aspect of the question, and the disappearance of the carbon and the nitrogen in the water from this cause, it must, of course, be taken into consideration in a sluggish river, and especially in the summer time; but in the time occupied in falling 360 or 700 feet no biological action could take place, and therefore the cause of the reduction of carbon or nitrogen must be sought either in the chemical action of the air or of the material mixed with the water. He had not referred to Professor Way's papers, as he had worked at the subject entirely from his own point of view, but he was glad to find that the results agreed so well.

Mr. WARINGTON said he did not mean to intimate that Professor Way had experimented on peat, but with such brown drainage waters as occurred on a farm, coloured with humic matter.

Mr. HARTLEY said the results obtained by Prof. Way seemed to confirm those obtained by Mr. Kinahan in his laboratory. With regard to the descent of peaty water over falls of 5,000 or 6,000 feet, with the results which had been mentioned, it was a most satisfactory confirmation of the view that there could be no considerable amount of oxidation taking place by the action of the air, because, if such an action took place as had been supposed with a fall of fifty feet, in the case of the South American rivers, they ought to be completely bleached, even if they were almost black before the aëration took place.

The CHAIRMAN said the Society was much indebted to Mr. Hartley for having brought forward these experimental results, which formed a valuable contribution to our knowledge on the question of oxidation, and apparently were quite conclusive, so far as peaty matters were concerned. On the other hand, Mr. Warington was quite right in warning them not to be too hasty in drawing conclusions as to the oxidisability of other vegetable matters which were found in water. He concluded by proposing a vote of thanks to Mr. Hartley, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

MINERS' SAFETY LAMP.

The following is the official information respecting the premium offered by Mr. Lever. The announcement that the Council of the Society of Arts had appointed Prof. F. A. Abel, C.B., F.R.S., one of the judges, was made in the *Journal* for March 16th (see *ante* p. 419).

Mr. Ellis Lever, of Culcheth-hall, Bowdon, Cheshire, agrees to hand over to the Central Board of the Miners' National Union, the sum of five hundred pounds, to be paid as a premium to any person, either in or out of the United Kingdom, who shall invent a portable electric or other safety lamp, to be used in mines. The following are the conditions :—

1. The five hundred pounds to be invested in the names of three trustees, one of whom shall be Mr. Thos. Burt., M.P., the other two to be chosen by the Central Board of the Miners' National Union.

2. The lamp to be perfectly self-contained electric lamp, or other lamp, which the working miners can conveniently carry from place to place in the mine, which will continue to give a useful amount of light for not less than twelve hours, and which will not cause an explosion of gas under any circumstances at all likely to represent conditions which may occur in actual practice.

3. The efficiency of the lamps put in for competition, to be submitted to five gentlemen, composed as follows :—Three scientists to be named hereafter, one to be selected by Mr. Lever, one by the Council of the Royal Society, and one by the Council of the Society of Arts, one person representing the Mining Engineers, chosen by themselves, and one person representing the workmen, chosen by the Central Board of the Miners' National Union.

4. The adjudicators to meet in London after the allowed time for sending in lamps for competition has elapsed.

5. The prize will not be awarded to any lamp now in use.

6. Not drawings or specifications, but lamps in a condition fit to be tested must be sent for examination by the adjudicators.

7. The lamps must be sent to No. 2, Victoria-street, Westminster, London. No lamp to be sent in before the 1st of December, or none later than the 31st of December, 1883.

8. If a lamp, meeting the requirements herein stated, has not then been invented, the five hundred pounds to revert back to Mr. Ellis Lever.

ELLIS LEVER.

THOS. BURT,
President, Miners' National Union,
35, Lovaine-crescent,
Newcastle-on-Tyne.

WINES OF SWITZERLAND.

Consul Adams, of Geneva, states that, though the decrease in the yield of the French vineyards, since the invasion of the phylloxera, has affected the wine trade of the whole of Europe, the deficiency has been partly met by the importation into France of Spanish and Italian grapes, partly by the manufacture of artificial wines from dried grapes, which is now a recognised and considerable industry in the south of France and at Geneva, and partly by the introduction of the wines of Italy, Spain, Hungary, and Greece. According to Consul Adams, certain of the Swiss wines deserve attention as substitutes for the Rhine wines and the white wines of France. The total extent of land under vine cultivation in Switzerland amounts to 85,929 acres, and the whole area may be divided into four districts—the valley of the Upper Rhine; the basin of Lake Neuchatel; the basin of Lake Geneva and the Upper Rhone emptying in it; and the Italian slopes of the Alps. The Upper Rhine produces a white wine, which is chiefly used for home consumption, and not exported; and a variety of red wines, some of great excellence, are produced in the Italian cantons; these, however, like many other Italian wines, suffer in transport. The average yield is estimated at 1,600 litres per acre, thus giving a total for the whole of Switzerland of about 137,486,400 litres, valued at 41,245,920

francs. To this sum may be added, for the exportation of grapes, largely used in neighbouring countries for the production of artificial wines, about 1,562,500 francs. According to a careful estimate, based upon the harvest of 1877, the annual consumption was 150,510,000 litres of native wine, and 107,334,000 litres of foreign wine, in all, 257,844,000 litres, or ninety-six litres to each inhabitant. Of the vines from which the Swiss white wines are produced, some are indigenous, others have been imported, chiefly from France. In the two lake districts of Neuchatel and Geneva, from which all the best export wines come, a single stock, known as the Chasselas in three varieties, the *fondant roux* or russet, the *fondant vert*, and the *fondant gris*, has superseded the others. In France, this wine is only grown for table use, the corresponding French wines, *Montrachet*, *Meursault*, *Mesnil*, and *D'Avize*, *Chablis*, &c., being produced from a stock known as the *Pincau*. In the Neuchatel district, the Chasselas produces a variety of wines, of which the better known are the *Mauler*, and the sparkling *Cortaillod*, sold extensively as a substitute for champagne. The most extensive and productive vineyards are those of the canton of Vaud, on the north shore of Lake Geneva, these producing alone a fourth to a half of the whole yield of Switzerland; next in importance are those of the cantons of Tessin, Zurich, and Valais, the aggregate extent of the vineyards in these three cantons being about 35,680 acres. The best Vaudois wines for export are the *D'Esalay*, the *Yvornes* (*Clos du Rocher*, *Grosse Grille*, &c.), the *Villeneuve*, and the wines of *La Côte*. To these may be added nearly all the wines of Valais produced in the Upper Rhone Valley above the Yvorne district. Owing to the peculiar climate and soil, most of them have a special character indicated by the names under which they are sold, *Johannisberg*, *Malvoisie* (*amère et flétrie*), *Gros*, and *Petit Rhin*.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

APRIL 4.—"The Measurement of Electricity." By J. N. SHOOLBRED. Dr. C. W. SIEMENS, F.R.S., Chairman of Council, will preside.

APRIL 11.—"The Portrush Railway and the Transmission of Power by Electricity." By ALEXANDER SIEMENS and Dr. HOPKINSON.

APRIL 18.—

APRIL 25.—"Economy of Sanitation." By CAPT. DOUGLAS GALTON, C.B., F.R.S.

MAY 2.—

MAY 9.—"English and Foreign Silver Work; with Some Remarks on Hall-markings." By WILFRED CRIPPS, F.S.A. Sir PHILIP CUNLIFFE-OWEN, K.C.M.G., C.B., C.I.E., will preside.

THE DATES OF THE FOLLOWING PAPERS ARE NOT YET FIXED.

"Electricity as a Motive Power." By PROF. GEORGE FORBES.

"Technical Education in connection with Intermediate Schools." By PHILIP MAGNUS, B.Sc., B.A.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at Eight o'clock:—

APRIL 3.—"The Trade Routes of Persia." By COL. BATEMAN CHAMPAIN, R.E. Major-General Sir LEWIS PELLY, K.C.B., K.C.S.I., will preside.

MAY 1.—

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings at Eight o'clock:—

APRIL 12.—"The Formation of Diastase from Grain by Moulds." By R. W. ATKINSON, B.Sc. Prof. CHARLES GRAHAM will preside.

APRIL 26.—"A New Process for the Separation and Recovery of the Volatile Constituents of Coal." By T. B. LIGHTFOOT, M.Inst.C.E.

INDIAN SECTION.

Friday evenings at Eight o'clock:—

APRIL 6.—"Historical Development of the Different Settlement Systems of British India." By W. G. PEDDER. Sir JAMES CAIRD, K.C.B., will preside.

APRIL 20.—"Fisheries of India." By Surgeon-General FRANCIS DAY.

MAY 4.—"Some Notes on the Domestic Architecture of India." By C. PURDON CLARKE.

MAY 25.—

CANTOR LECTURES.

Monday evenings at Eight o'clock:—

Third Course, on "The Decorative Treatment of Metal in Architecture." By GEORGE H. BIRCH, A.R.I.B.A.

LECTURE I.—APRIL 2.

Introduction.—The employment of subsidiary arts in architecture. The decorative treatment of the precious metals in ancient architecture. Its occasional use in Egyptian, Assyrian, Babylonian, Mede, Persian, and Jewish architecture. Greece and Rome, the Christian Dispensation.

Bronze.—The Bronze age. Nature and qualities of bronze. Its earliest use. Nineveh, Babylon, Mycenæ, Pelasgic, and Etruscan. The classic period.

LECTURE II.—APRIL 9.

Bronze (continued).—Rome, Lombardy, Germany, Hildesheim, Italy, during the Middle Ages. The culminating point during the Renaissance.

Iron Work.—The Art of the Blacksmith, and the use of wrought iron in the north of Europe.

LECTURE III.—APRIL 16.

Iron Work (continued).—Germany—Augsburg and Nuremberg—15th and 16th centuries. England, 17th century.

Lead.—How used. Artistic treatment of the Middle Ages. Its capabilities.

Conclusion.—The use and abuse of metal work; modern bronze work; the decorative treatment of the metals, as applied in these days; our failures and successes.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 2...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. G. H. Birch, "The Decorative Treatment of Metal in Architecture." (Lecture I.)

Farmers' Club, Inns of Court Hotel, Holborn, W.C., 1 p.m. Mr. W. Stratton, "The Management and Application of Manures."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. Chris Anderson, "The Feasibility and Construction of Deep-sea Lighthouses."

Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. W. E. Evans, "Land Tax: its Assessment and Redemption."

Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Professor J. Buckman, "Natural and Artificial Grasses: Variation in Form and Quality."

Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. The Venerable Archdeacon Bardsley, "The Arguments in Regard to the Descent of Man."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. C. Napier Hake, "The Stassfurt Salts and their Mode of Treatment."

TUESDAY, APRIL 3 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Colonel Bateman-Champain, "The Trade-Routes of Persia."

Royal Institution, Albemarle-street, W., 3 p.m. Professor J. G. McKendrick, "Physiological Discovery: A Retrospect, Historical, Biographical, and Critical." (Lecture I.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. William Smith, "Summit-level Tunnel on the Bettws and Festiniog Railway."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

1. Remarks by Dr. Birch on "Canopic Vases" exhibited by Mr. D. Parish. 2. Dr. S. Louis, "Old Jewish Rules and Practices for the Relief of the Poor".

Zoological, 11, Hanover-square, W., 8½ p.m.

WEDNESDAY, APRIL 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. N. Shoolbred, "The Measurement of Electricity."

Entomological, 11, Chandos-street, W., 7 p.m.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Mr. W. A. H. Naylor, "The Bitter Principle of *Hymenodictyon excelsum*." 2. Mr. W. C. Ondaatje, "Remarks on Medicinal Plants of Ceylon." Exhibition of a complete series of the barks of the cinchonas cultivated in the Indian plantation at Ootacamund, including herbarium specimens of the same, received from the Indian Government.

Archæological Association, 32, Sackville-street, 8 p.m. Dr. Douglas Lithgow, "Saul near Downpatrick, and its Vicinity, with Special Reference to St. Patrick."

Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

THURSDAY, APRIL 5...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Alf. Moloney, "The India-rubber (*Landolphia Owariensis*) of the Gold Coast." 2. Mr. F. W. Phillips, "New Species of Infusorian allied to *Gerda*." 3. Mr. C. B. Clarke, "The genus *Hemicarex* and its allies."

Chemical, Burlington-house, W., 8 p.m. Mr. Lewis Wright, "The Estimation of Hydrogen Sulphide, and Carbonic Anhydride in Coal Gas."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. The Second Conversazione.

Archæological Association, 32, Sackville-street, W., 4 p.m.

South London Photographic (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. Waldstein, "Art of Pheidias." (Lecture I.)

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Society of Engineers, 6, Westminster-chambers, S.W., 7½ p.m. Mr. R. Peregrine Birch, "Water Supply and Drainage." (Lecture VIII.)

Institution of Civil Engineers, 25, Great George-street, Westminster, S.W. Special Meeting, 8 p.m. Dr. J. Hopkinson, "Some Points in Electric Lighting."

FIRDAY, APRIL 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. W. G. Pedder, "The Historical Development of the Different Settlement Systems of British India."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. W. Geikie, "The Canons of the Far West."

Geologists' Association, University College, W.C., 8 p.m. 1. Mr. B. B. Woodward, "Note on the Drift Deposits of Hunstanton, Norfolk." 2. Prof. G. S. Boulger, "Some of the Optical Characters of Minerals."

Philological, University College, W.C., 8 p.m.

SATURDAY, APRIL 7...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Geikie, "Geographical Evolution." (Lecture I.)

Journal of the Society of Arts.

No. 1,585. Vol. XXXI.

FRIDAY, APRIL 6, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The first lecture of the third course of Cantor Lectures on "The Decorative Treatment of Metal in Architecture," was delivered by Mr. George H. Birch, on Monday evening, April 2nd. The lecturer commenced with a description of the use of the precious metals in ancient architecture, and then proceeded to describe the general use of bronze in the earliest times, and during the classic period.

A collection of bronze objects were exhibited, in illustration of the lecture, by Messrs. Gardner. In the Reading-room were also exhibited an elaborate bronze fire-place and overmantel, ornamented with numerous designs of sporting subjects; iron fire-places and overmantels in the Adam style; two vases and a figure in bronze, by the Coalbrookdale Co.; a collection of artistic chandeliers and pedestals reproduced from famous Italian originals, by Messrs. Perry and Co.; ecclesiastical brasswork, by Messrs. Cox, Sons, Buckley and Co.; and an iron casting by the Carron Company.

These objects will remain on view each day, from 10 to 4 (with the exception of Saturdays, from 10 to 2), until the close of the course of lectures.

Proceedings of the Society.

FOREIGN AND COLONIAL SECTION.

Tuesday, April 3rd, 1883; Sir Lewis Pelly, K.C.B., K.C.S.I., in the chair.

The paper read was—

THE TRADE ROUTES OF PERSIA.

By Col. Bateman-Champain, R.E.

Every nation in the civilised world is more or less directly interested in the development of trade with Persia, but it will be admitted that Great Britain and Russia are the countries which are most immediately concerned in the subject.

In examining the conditions which affect the present state and the future prospects of Russian trade, as compared to our own with Persia, it is not my intention to raise what is called a political discussion; but, at the same time, it is impossible to treat the matter at all without recognising clearly the fact that the establishment and extension of commercial enterprise, in these regions, are tantamount to the establishment and extension of political influence.

Now, one great bar to the extension of international trade is the want of facilities for locomotion, and in this respect Persia continues in a most deplorable state. The country under the rule of the Shah covers an area nearly three times as large as that of France, and may be roughly described as an elevated plateau, about 4,000 or 5,000 feet above the sea, surrounded by chains of barren, rocky mountains. The interior is intersected by ranges running usually from north-west to south-east, while vast tracts of the more level country are utterly irreclaimable salt deserts. The rainfall, except in the provinces bordering the Caspian, is scanty, averaging, it is calculated, not more than from five to ten inches in the year. My present object, however, is not to give a minute description of the physical or geographical pecularities of Persia, but to afford a general idea of the natural, and, perhaps, the artificial, barriers which impede free locomotion throughout the empire.

Mainly, I think, in consequence of the want of water, the population is small, probably not exceeding four to six millions. With the exception of the Karùn, in the south-west, to which I propose particularly to direct attention, there is not a navigable river in the empire, and the streams delineated on the maps are, for the most part, intermittent torrents in the spring, and dry by the end of summer.

Roads, as we understand the word, do not exist. The transport of goods is effected by means of camels and mules, which slowly plod along over desert and mountain, marking out, in the course of centuries, tracks which

are accepted as highways. Along many of these highways, private munificence has erected caravanserais at the halting places, where travellers and their beasts find shelter at night. A day's march for caravans averages about twenty to twenty-five miles.

Bridges and causeways are few, and it is not at all uncommon for caravans to be delayed for days on the bank of some swollen stream, a dozen yards or so in width. In summer, the heat during the day-time is excessive, and marching is almost always done at night. In winter, the passes are frequently blocked by snow for weeks at a time. So that it will be readily understood that commercial communication with the markets of Central Persia is difficult and irregular.

Yet, considering the population, the imports and exports are by no means insignificant. The wealthier classes in Persia are inclined, as elsewhere, to luxury, while even the peasants and the more indigent require and consume many articles which the country itself does not produce. Tea and sugar, for example, are in universal demand. Manchester goods, glass, crockery, drugs, iron, copper, and a large variety of wares are imported from abroad; while, on the other hand, Persia sends forth horses, sheep, tobacco, silk, cotton, dry fruit, opium, wool, hides, grain, carpets, rugs, and other similar productions.

The value of the exports is said to be about the same as that of the imports, somewhat over three millions sterling, but great uncertainty attaches to the statistics obtainable. Twenty or thirty years ago, the silk trade of Ghilan was a very important branch of Persian commerce, the annual export of raw silk being as much as 20,000 bales, or, 400,000 lbs. avoirdupois, worth £700,000 sterling, but disease has played havoc with the silkworms, and this trade has now dwindled from 20,000 to 5,000 bales. Of late years opium has been grown, in many districts of Persia, with success, and contributes largely to the value of the exports, which would, were silk and opium both eliminated, be quite unable to balance the imports. The principal markets of Persia are:—Teheran, the capital, since the rise of the present reigning dynasty of Kajars, a tribe long established near the south-east corner of the Caspian. Were it not the capital city of Persia, the mercantile importance of Teheran would not, I think, be very great. It contains about 120,000 inhabitants, and, though its productions are insignificant, its consumption is, of course, great. Tabreez, the largest city in the kingdom, has a population of nearly 150,000; it is the seat of government of the heir to the throne, and is by far the busiest trade centre of Persia. Next comes Kashan, with a thriving and industrious population of probably 90,000 souls. The bazaars of this city are very extensive, and a great trade is carried on in manufactured silk, copper vessels, pottery, and dried fruits. Next to Kashan in population, far before it in historical renown, is Ispahàn, the once famed capital of Persia—"Ispahan nisf-i-jehàn"—half the world, according to the ancient but now marvellously inapplicable doggrel. The city is, at the present day, mainly remarkable for its extensive mixed bazaars and palaces, and its population can hardly be more than 60,000 or 70,000 souls. It is the head-quarters of the Persian opium trade, a business which seems to be assuming much importance. According to Colonel Ross, British Resident at Bushire, the number of cases shipped at that port, principally for Chinese consumption, has risen steadily, during the last ten years, from 870 cases, worth 696,000 rupees, to 7,700 cases in 1880-81, worth 8,470,000 rupees. Ispahan is the seat of government of the Shah's eldest son, who bears the title of the Zil-i-Sultàn. His royal highness is not the recognised heir to the throne, owing to the circumstance that his mother was of comparatively lowly origin.

After Ispahan come Shiraz; Meshed, remarkable for its shrine, visited yearly by hosts of pilgrims; Yezd, noted for its brisk trade in silk and opium; Kirmàn, for its shawls and carpets; Kermanshah, Hamadan, Koom, Zenjan, Kasvin, and other towns which it is not necessary to name.

In developing commercial intercourse with these Persian markets, the natural base of the British merchant is the Persian Gulf, that of his Russian rival is the Caspian Sea and the Caucasian provinces, which reach to within some eighty miles of Tabreez.

The trade routes from the Persian Gulf to the interior are three in number. Commencing Abbas to Yezd and Kirmàn, the remoteness of the port in question putting it out of the field for goods destined for Shiraz, Ispahan, and the other large cities of central Persia. Bundur Abbas itself can boast a good harbour, but the locality is hot and unhealthy, and its palmy days have long since passed away. The road to the interior is exceedingly rugged and difficult, rising at some points to nearly 9,000 or 10,000

feet above the sea, at which elevations all communication is stopped, in severe winters, for weeks, or even months at a time.

Between Bundur Abbas and Bushire are one or two minor ports, such as Lingah, Charakh, &c., which have some little importance in connection with the pearl fisheries and coasting trade; but no practicable route inland is to be found before reaching Bushire. This is by far the most important place in the Gulf, and through it passes the great bulk of the trade between Persia and Great Britain, India, and the far East. Yet the disadvantages of the Bushire route are by no means slight. There is no harbour, and vessels of any size are compelled to anchor in the roads, three or four miles from land, exposed to some risk, and great inconvenience. The road to Shiraz (about 200 miles) is execrably bad, crossing range after range of mountains, by six formidable passes, one of which is more than 7,000 feet above the sea. From Shiraz to Ispahan (nearly 300 miles) the natural difficulties are less; indeed, for a great part of this section the track lies along level and open valleys. Still it may be pointed out that no efforts have been made by the Persian Government to improve this most important trade route, and the traveller of to-day finds the conditions of his journey almost precisely the same as those which were experienced by his predecessors of the time of Marco Polo.

The third trade route is that by the Tigris to Baghdad, and thence, by a moderately good natural road, to the Persian frontier, near Khanakin, and through Kermanshah and Hamadan to Teheran, the distance from Baghdad to the capital of Persia being 500 miles. As to this Baghdad-Teheran line, I shall have a few words to say later on, but with special regard to these southern routes, I must again lay stress on the lamentable absence of all endeavour on the part of the rulers of Persia to lessen the natural difficulties of locomotion. Mr. Dickson, of her Majesty's Mission, observes, in his latest trade report, dated August 30, 1882, that—

"The want of carriageable roads continues to obstruct the development of trade. The fact is, that a feeling still prevails amongst some of the influential classes that Persia's safest policy is 'to let well alone,' that the requirements of the State are sufficiently satisfied by the present limited resources of the country, and that, so long as it remains in its actual condition, they will be allowed to manage their own affairs; whereas, every step towards improvement might tend to increase the influence of the foreign, to the detriment of the native element. In spite of these ideas, however, the current of civilisation is gradually forcing its way into this country. On my return from Europe last autumn, I was agreeably surprised to find that a very fair road had been constructed between Kasvin and Teheran; that a supply of carriages and carts, obtained from Russia, was available for travellers and carriers; and that the stations were comfortably built at regular distances of twelve miles from each other."

I have explained that nothing, or next to nothing, has been done by man to improve the roads to and from the Persian Gulf; but if we look at the communications with the Russian bases of operations in the north, a different tale has to be told. Here the change for the better, which has taken place since I first went to Persia in 1862, is very striking, and the inevitable results are clear to the most casual observer. To begin with, the natural difficulties of the country are far less in the north than in the south, the road from the Russian frontier at Julfa on the Arax, through Tabreez to Teheran, being the easiest 500 miles stretch in the empire.

The Shah himself rarely leaves the neighbourhood of the capital, his yearly tours, of which shooting is a leading object, being generally confined to the most northern provinces; and it is only natural that his attention and efforts to develop the resources of his kingdom should be primarily directed to this part of the country immediately under his eye. There is no doubt also, that the successive Russian ministers at the court of the Shah, have exerted themselves incessantly to induce His Majesty to devote money and labour to the construction of roads connecting the capital with the Caspian Sea. A reference to the map of Persia will show that all the so-called seaport towns of Ghilan and Mazanderan are situated some fifteen or twenty miles inland; the reason being that, in former days, and until exterminated by the power of Russia, the Turkoman pirates, who infested the Caspian, were constantly pillaging the Persian settlements within easy reach of the sea, so that for dear safety sake, the towns of Resht, Barfrush, Amol, Sari, and Astrabad, stand well back.

Each town had its own little portlet (if I may coin a word) on the neighbouring beach, and, I suppose, nothing valuable was ever left there at night. Thus the portlet of Resht is Enzelli, that of Amol and Barfrush is Meshed-i-Sar, that of Astrabad, Gez, and so on.

Swampy forest generally intervened between the town and its little port, and it would have

been deemed the height of rashness to do anything to facilitate the crossing of this defensive border land. I recollect that, as recently as 1865, it used to be nearly impossible to traverse the morass between Resht and Enzelli. A peculiar breed of thick-limbed ponies was kept for this particular journey, and these intelligent animals could, under favourable circumstances, get over more than a mile an hour! The ground was a kind of heavy swamp, covered with rotting stems of unwholesome trees and evil-looking weeds. One's pony used to feel about for some time with one foreleg before deciding on each step, and very frequently he would stick altogether. Sometimes two legs would find bottom, and the other two would not, and the position assumed, in consequence of these manœuvres, by one's saddle would naturally be embarrassing to the most accomplished horseman. After very heavy rains this line of country became, of course, impracticable, and the traveller had to wait his chance. Fortunately, time is not of the slightest consequence in Persia.

All this is now entirely changed. An admirable road, fit even for carriages, connects Resht with Pir-i-Bazaar, near Enzelli. The road inwards, through the mountains, towards Kasvin, has also been vastly improved, and, as shown by Mr. Dickson's report, quoted above, the hundred miles between Kasvin and the capital are actually traversed in carriages —the only ones, I may observe, in all Persia.

Similarly, the road from Meshed-i-Sar to Teheran, over which I journeyed two years ago, and which passes through very formidable ravines and gorges, has been properly laid out with considerable engineering skill, and is now as good a road as could be desired. For a long time, the services of an excellent Austrian officer, Captain Gasteiger, an engineer of ability, have been devoted to the improvement of these Mazanderan communications, and it is undeniable that in this northern part of the country, and in this only, the last twenty years have witnessed a wonderful change.

And if such progress has been made within the limits of the Persian empire, how surprising are the advances made by Russia. Since the date of the Crimean war, lines of railways have been made in every direction over the face of the country. That magnificent river, the Volga, is being utilised as a grand commercial highway by hundreds of steamers. The Caspian Sea, on which no flag but that of Russia is allowed to float, is also the means of transporting goods to the shores of Persia. A year ago, the ordinary line of communication between Russia and Teheran was by rail to Tsaritzin, near to the Volga's mouth, and thence, by river, to the port of Astrakhan, and by Enzelli or Resht. Astrakhan, however, laboured under the great disadvantage of being closed to all traffic by the rigours of the climate from November to April. Now, however, that the railways into Caucasus have been further developed, and the line between Tiflis and Bakou completed, communication with Persia will be maintained with ease and regularity throughout the year. The acquisition of Batoum, the long coveted harbour on the Black Sea, will add enormously to the advantages of the Russian base of operations, and, as stated by Vice Consul Peacock, on the 8th April, 1882, by connecting Batoum with Tiflis, the Caspian territories, and the routes of Persian caravans, it is expected to raise this port to an important position, and to make it the principal shipping place and emporium for Eastern trade. Probably, no long time will elapse before a railway connects Tiflis with the Persian frontier near Tabreez. Referring to railways in Persia, I am not sanguine as to their succeeding; but it seems too certain that if any be actually carried out, it will be in the north, and not in the south. A year ago, a concession for a line from Resht to Teheran was given, by the Shah, to Mons. Boital, the line to be opened by 1885, and after sixty years to become the property of His Majesty. Caution money (50,000 tomans) to be lodged, and forfeited in case M. Boital fails to fulfil the conditions imposed. This is one of many similar negociations, all of which have fallen through, and the caution money confiscated by the Persian authorities.

Time will not allow of my saying more on the increased facilities recently secured to the benefit of Russian trade with Persia, the natural results of which are already unmistakeably evident.

British trade is being steadily driven back, not only from the northern markets, but from Ispahan and other cities, which might be expected to lie within our natural circle. For we possess one enormous advantage, and that is, that we can transport our wares by water direct, without land carriage or transhipment of any kind, to the very soil of Persia. The fact that our own trade is receding before that of Russia is obvious to all who have travelled in Persia, and is admitted in the reports of

our consular and diplomatic agents. The latest returns by Colonel Ross show that the trade through Bushire is seriously falling off, while the figures sent in by Colonel Lovett, at Astrabad, prove that, through the Caspian ports, trade is steadily growing. Mr. Mackenzie, a member of the firm of Gray, Dawes, and Co. (Gray and Paul, at Bushire), the only purely English house, I think, which maintains a branch establishment on Persian soil, states that:—

"In former years we used to ship largely iron, copper sheets, candles, and earthenware. All these, however, for some time past, we have been quite unable to import at a profit, and, from the fact of their not being imported by others to Bushire, I take it that the supplies come from the north *viâ* Russia."

Col. Murdoch Smith, of the Royal Engineers, who has been a constant resident in Persia since 1863, and whose duties oblige him to travel often to and from Bushire, supports this view that English trade with Central Persia is rapidly diminishing. Mr. Mackenzie also mentions one remarkable and discouraging circumstance, that his firm, which found it well worth while to establish agencies at Ispahan and Shiraz, in 1868, was driven to abolish them in 1879.

Now, considering the geographical position of Persia, it seems to me, for various reasons, well worth while to examine the measures which might be adopted with a view to remove some of the difficulties which confront commercial enterprise in the south.

My friend, Sir Frederick Goldsmid, than whom there is no better authority on questions of this description, looks forward to the establishment of a grand line of railway from Ispahan to Kirman, and so through Baluchistan to our Western Indian Frontier at Karachi. He knows this line of country, perhaps, better than anyone alive, and he is certain that the physical obstacles to such an enterprise could be easily surmounted.

Far be it for me to say that such a plan will never be carried out, but it will certainly not be attempted yet awhile; and under any circumstances, for trade purposes, no railway could compete with the sea. A railway inland from Bundur Abbas, or from Bushire, would be so costly as to be impossible, and even to improve the roads to any material extent would, for a similar reason, be out of the question.

There remain two practical ways of getting at the interior of Persia, viz., by the Karùn River to Shuster and Dizful, or by the Tigris to Baghdad, and thence by road to Kermanshah, Hamadan, and the capital.

The Karùn, the only navigable stream in all Persia, was ascended by Captain Selby, of the Indian Navy, in 1842, and a most interesting account of his trip was published in the *Journal of the Royal Geographical Society* for August, 1844. As far as Ahwaz, the river presents no difficulties whatever at any season of the year. In fact, during the Persian War of 1856-57, our gunboats steamed up the river and captured the place. But across the stream, at Ahwaz, lies a kind of partly natural, partly artificial weir of sandstone rock, a sketch of which, drawn last year by Captain Wells, R.E., will be seen attached to the map of Persia, hanging behind me. It is true that Captain Selby, with the untiring energy and determination of a British sailor, managed to hoist his steam vessel, the *Assyria*, of more than 400 tons, up the rapids, and continued his trip to Shuster, but this obstacle, as it exists, would render through running impossible. It would be a grave mistake, according to Captain Wells, and I quite agree with him, to blow up or remove this natural weir; on the contrary, it would be advisable, perhaps, to add to it with the object of regulating the amount of water above Ahwaz during extra dry seasons. Were a short canal cut from A to B at a cost of a few hundred pounds, and two locks established, navigation between Mohammerah and Dizful could be carried on the whole year through with ease and safety. Such a canal would not exceed 2,350 yards in length, and would in no place require excavation to a greater depth than thirty-five feet, even to give eight feet of water in the canal. The soil, too, is well adapted to such a work. In the absence of such a canal, goods would have to be transhipped to and from one set of boats below, and another set above, the rapids, a tramway connecting the wharves. But in a paper of this description I need not trouble you with details. I merely assert, with the utmost confidence, that were navigation permitted on the Karùn river, goods could be landed from England at Shuster and Dizful at an excessively small cost, and without the smallest risk, except, of course, that of an ordinary sea voyage. Mohammerah, the port of the Karùn, offers the most exceptional advantages as a maritime commercial town. It can be approached from the sea, not only by the Shat-el-arab, but by the Khor Bamishir, the old embouchure of the Karùn, now communicating

with the Shat-el-Arab by an artificial waterway, the Haffâr. Vessels of large size can anchor close to the banks at Mohammerah, the climate of which town is, considering its latitude, remarkably cool and healthy. English goods here could be transhipped with ease to smaller steamers, suitable for the Karùn, and Mohammerah would rapidly develop into a place of great commercial importance.

Thus, were the Karùn utilised as suggested, the fertile districts of Shuster and Dizful, at present cut off from the trade of the world, could be reached by water communication in the cheapest and most satisfactory manner; and I would strongly advise those interested in the question to consult Captain Selby's paper, to which I have been referring. He writes in the most sanguine spirit of the capabilities of this route, and gives, I venture to think, excellent reasons for the conclusions he draws. Let me quote one paragraph :—

"A commercial treaty entered into with Persia; our steamers running on the rivers of Mesopotamia—those rivers strictly in the Persian dominions, and having been easily and safely traversed by a vessel possessing much less capabilities for navigation than the boats now built for that purpose—what prevents us, I would ask, from commencing that intercourse with the inhabitants which their advancement in civilisation and our own interests so imperatively demand? . . . An extremely healthy and productive region, friendly tribes on the banks of the rivers, the country fertile in objects of interest, both to the merchant and geographer—our present political relations with Persia considered—all tend to point out these rivers as the means where we may not only increase our political power, but our commercial advantages. I feel assured that the day is not far distant when the Karùn and Dizful will be as well known and traversed as the Indus or Ganges."

As a matter of fact, we have not advanced a foot in this direction since Captain Selby wrote—more than forty years ago.

On the 15th January last, I had the honour of reading before the Royal Geographical Society a paper on this subject, which has been printed in its "Journal" for March. In the same journal are complete and valuable accounts of journeys made between Shuster and Ispahan by Mr. Mackenzie, in 1875; and still more recently by Captain Wells, R.E., who examined the other principal roads which traverse this part of Persia. M. Schindler, a German officer, in the service of the Persian Government, has also communicated to the Royal Asiatic Society an account of the road from Koom, through Burujird, to Dizful and Shuster, so that it would be waste of time for me to trouble you now with purely geographical particulars, already on record and easily accessible.

Opportunities which were open to us in Captain Selby's time, and long afterwards, have, unfortunately, been allowed to slip, and our influence at Teheran is not now strong enough to obtain the Shah's sympathy for a scheme which would benefit Persia in the highest degree.

Four or five years ago, Messrs. Gray, Paul, and Co., of Bushire, offered to run steamers up and down to Karùn, but permission to do so was distinctly refused by the Persian Government. Colonel Murdoch Smith, R.E., writing to me on the 5th of last February, says :—

"It seems the Persian Government have an insuperable objection to allowing English vessels in the Karùn. All that part of the country beyond the Bakhtiari mountains is inhabited by Arabs and Lùrs, who can hardly be called Persians. It is remote and somewhat inaccessible from the capital, and therefore not very firmly held. These circumstances seem to make the Government, or, at least, the Shah himself, think that English trade and navigation would lead to predominating English influence, if not actual occupation."

It is fair to recollect that, at the close of the Persian war, General Jacob strongly advised the Government to retain possession of Ahwaz, Shuster, the province of Khuzistan, and the Island of Kharg. The Shah, no doubt, is aware of what was recommended.

In another note, received by me lately from a correspondent at Teheran, it is stated that—

"The very name of the Karùn is, to the Shah, as a red rag to a bull; so, as long as his Majesty reigns, there is no use discussing the project."

It is certain that, to Russian influence must be ascribed this determined opposition to a very promising and practicable enterprise.

Let us now examine, for a few minutes, the possibility of utilising more freely than at present, the road between Baghdad and Teheran.

Mr. Dickson, her Majesty's Secretary of Legation in Persia, in his report, dated August 30th, 1883, writes thus :—

"The line that would, in my opinion, best suit the requirements of Persia, would be the one I ventured to suggest on a former occasion, viz., from Teheran to Baghdad. It would be comparatively easier and less costly to construct (than the Resht-Teheran railway); it would pass through Kermanshah, one of

the richest grain-producing provinces of Persia; the capital would be always plentifully supplied with provisions, the pilgrim traffic would increase, and contribute largely to the receipts of the line, and goods would only have to change once—that is at Baghdad, whence they could be shipped to any part of the world with little trouble, and at a smaller cost than by any other route; whereas, by the Resht line, goods would have to be shipped at Enzelli, landed at Baku, transferred to the Tiflis Poti railway, and again shipped at Poti. . . . . A branch line could be carried from Kermanshah or Hamadan, to Shuster or Dizful, whence goods could be exported by the Karûn. This would give Persia an independent outlet for her commerce, and save her the transit dues which would be exacted in Turkey or Russia. . . . . As regards means and rapidity of transport, the Poti Tiflis route is decidedly superior to either the Bushire-Shiraz, or the old Trebizond-Erzeroum and Tabreez routes, but the obstructions suffered from the Russian Custom-house officials are so grievous, that merchants are again reverting to the Trebizond-Erzeroum route."

In this evening's paper I have not referred to this last mentioned tedious and old-fashioned line. Not many years ago, British imports to Persia *viâ* Trebizond, were valued at no less than three-quarters of a million sterling per annum, but it is obvious that the Caucasus railway system can now monopolise all traffic from the Black Sea, whenever the Russian authorities may please.

Mr. Plowden, our Political Agent, and Consul-General at Baghdad also warmly advocates the construction of a railway from Baghdad; and, touching on the same question, Colonel Murdoch Smith points out that:—

"From Bussorah to Baghdad there is excellent river navigation, the development of which is at present unhappily limited by the jealous restrictions of the Turkish Government, who will not allow more than two English steamers on the Tigris. Were these restrictions withdrawn, and arrangements made for the passage of goods in transit, duty free, a railway from Baghdad to Kermanshah (about 220 miles) would probably pay. Unlike the other inlets to Persia, this route offers no great physical difficulties. . . . . The materials for making the railway would come by water to the terminus at Baghdad; thence to Khanakin, on the Persian frontier (100 miles); the ground is perfectly level, with only two moderate sized rivers to cross. From the frontier, the Persian plateau would be reached by an easy gradient. A railway from Baghdad to Kermanshah, if economically made and worked, ought to pay, and would undoubtedly give a great impetus to English trade in Persia. As matters now stand, it seems to me to be the only practicable project. The north is hermetically closed; the east, had we retained Kandahar, might have presented new and profitable openings; the old Trebizond route is destroyed in the south; physical obstacles at Bundur Abbas and Bushire, and political ones on the Karûn, bar the way.

Further information on many matters of great importance, as regards this Baghdad scheme, will be found in the discussion which followed the reading of my paper before the Royal Geographical Society, published in the March "Journal;" but it is obviously impossible for me, in treating a large question such as this, to do more than glance at many of its aspects.

The conclusion I draw, after long and careful consideration of the circumstances, is that political obstacles alone impede the extension of British trade in Persia.

I am by no means a Russophobist, I have travelled through that huge empire from Finland to the Black Sea; from Warsaw to Astrakhan; I have crossed the Caucasian provinces three or four times; I have descended the Volga over and over again, either from Nijni Novgorod or Tsaritzin to the Caspian; in short, there is no city of importance in Russia in Europe which I have not visited; but I pretend to no more than a most superficial and utterly inadequate knowledge of the country. I have met with great kindness and attention, and I am not blind to the many good qualities of the Russian of every rank; but I think I may truly say that I have rarely come across a Russian officer who would not, in familiar conversation, admit that the most ardent hope of himself and his comrades is, some day, to attack us in our Indian Empire. These gallant gentlemen know, of course, as little as I do of the future policy of their rulers; but if we recall the steps by which our conquests and annexations were carried on in India, in spite of the express prohibitions of the home authorities, we may allow that Russian military officers may, nay must, mould the destinies of their country in the far East to a very considerable degree. It is unnatural to expect that their vast empire, deprived of all outlet, except through northern harbours closed for half the year, should not seek to extend her sway to southern seas. Unluckily, this must be done, if at all, at our expense; but, instead of blaming Russians, I always feel inclined to say that if we cannot hold our own, we richly deserve to lose it. Moreover, Russia has to contend against threatening internal complications, and the sinews of war may be hard (even impossible) to provide. Still to my mind the real Russo-

phobist is the man who is afraid to adopt protective measures; who, rather than risk offending our rivals (who are certainly not over tender towards us), is eager to shut his eyes, and to draw back as Russia presses forward; to put off, in fact, by any means, the evil day, and leave an infinitely more evil day to be dealt with by the next generation. The Russians undoubtedly have the upper hand just now in Persia, and their object naturally is to push on their own trade, and consequently their political influence, and impede ours. Here are some remarks by the correspondent of the *Times*, which appeared in that paper on the 8th March, 1883:—

"It is not unimportant for certain European Powers to watch the development of Russian aims, and Turkish diplomacy is astute enough to discover that British interests would be endangered by the turning of Batoum into a central advance post of Indian trade and transit; and that the proposed Russian railways, and other means of communication, are all directed towards the same end, of which the Kilia project is only one step more, of antagonism to British Indian interests. Another Turkish argument is that a Russian and Austrian combination, with respect to Danube navigation, based on concessions to be made by the former to the political objects aimed at by Austria's policy in the East, may carry with it future danger to English trade and Eastern policy. These are views which I have recently obtained from private conversations with local officials."

During the last part of the Crimean war, the Shah of Persia was strongly tempted to throw in his lot with the Allies. Had he chosen to lift his finger, the Caucasus would have been up, and, in all probability, Persia could have regained the provinces wrested from her by Russia under the Treaty of Turkomanchai of 1828. Whether she could have retained them is quite another question; and it is certain that both the British and French ministers at Teheran counselled his Majesty not to move, being aware that it would have been highly inconvenient to accept Persia's aid during the war, and to protect her from the consequences of her policy afterwards. It was said, and with apparent truth, that the Emperor Nicholas, and his successor, Alexander, were so grateful for the benevolent neutrality maintained by the Shah, that they steadfastly set their faces against any further encroachments in Persian territory so long as his Majesty Nusruddeen should remain on the throne. I have heard it rumoured that a complete scheme for annexing the Caspian provinces of Ghilan and Mazanderan lies cut and dried among the military archives at Tiflis, and it is, in my opinion, quite possible that very many years will not pass before Russia will have extended her territories to the Elburz range, and claimed as her own the coast all round the Caspian. In the meantime she loses no opportunity to develop her influence by methods which I think we ought to adopt on our side.

I need scarcely say that I am not personally interested in our trade with Persia, nor any other country; but my attention happens to have been directed to the matter on which I have endeavoured this evening to throw some light. I do not presume to offer advice as to the precise steps which might be taken; I merely venture to hope that the subject may possibly attract the attention of commercial men, and lead them to inquire for themselves into the conditions which prevail in Mesopotamia and Southern Persia. My firm belief is, that a moderate investment of capital in these regions would lead to results eminently satisfactory, both from a national and from a financial point of view, and I am quite sure that, if that proved true, the benefits conferred on the countries I have mentioned would be incalculable.

DISCUSSION.

Mr. Martin Wood said Colonel Bateman-Champain had arrived at the conclusion that political obstacles only hindered the extension of British trade in Persia, but he would venture to add a word which might put those political obstacles in a different light. He maintained that had the Embassy at Teheran continued as it was once, under the guidance of experienced Indian political officers, the present state of things would have been entirely different. Colonel Bateman-Champain had quoted Captain Selby's report, made some forty years ago, when everything which was practicable was, in fact, described by that Indian naval officer; and it was interesting to call to mind how much had been done by the naval officers in the Indian service for the development of trade in the Persian Gulf; Sir Felix Jones amongst others. He must say he thought the reader of the paper had rather minimised the difficulties which would attend any railway enterprise in Persia, considering its present impoverished condition; but with regard to water communication, he was on surer ground. A great deal had been done to utilise the Gulf; and against the advantages which Russia enjoyed in the north might be placed the invaluable advantage of water communication, in the south. With regard to the Karûn River, he noticed, some two or three months ago, that negotiations were going on between

the French and the Government of the Shah, and at that time it was understood that a very favourable concession was given to French merchants. Bearing in mind the determination of the Persian Court to refuse British merchants any access to the river, this seemed somewhat strange; but it was, after all, only one strange thing among many others. But had there been at Teheran Indian political officers, men trained in the ways of Eastern courts, he believed all these things would have turned out very differently. It was interesting to hear about the trade routes, but there was the question of the trade itself, which he feared was wanting. Colonel Bateman-Champain had spoken of the great want of water, and it was difficult to see how that was to be got over. He feared that in Persia, as in many other eastern countries, it was due to the terrible denudation which had taken place. Eventually, perhaps, under a better system of government, something might be done toward restoring the forests, and so improving the condition of the country.

Mr. MACKENZIE (Messrs. Gray and Paul) said he could endorse what the last speaker had said with regard to the Foreign-office. Their want of success in Persia was mainly due to want of support from the Foreign-office in London. So far as the British officials on the spot were concerned, they had no reason to complain. The British Resident at Bushire, when he first went there and opened a house of business, was the chairman, Sir Lewis Pelly, and nothing could have exceeded the interest he took in doing anything he could to support him; he had no doubt that it was the same at Teheran; but when matters were referred home, they came to the Foreign-office, they were bandied about backwards and forwards, from one official to another, until they were pigeon-holed, and entirely lost sight of; at least that was the inference he drew. The Persians, themselves, were quite willing to follow any lead which was given them; he had found them free from any caste prejudices, and ready to receive the foreigner in the most hospitable and friendly manner. When he first when to Bushire, the Europeans all lived in the native town or village, there being no houses outside at all, except a small bungalow occupied by Colonel Pelly. During the famine, when the Mansion-house fund was distributed under his direction, he very wisely occupied the people who received relief in making roads, or rather in improving those which existed, and the effect of that was that now there was not a native merchant who did not pride himself on having a country house, and keeping a carriage. As to the Karùn River, there was no difficulty at all. He had been up it in a small steamer belonging to the Sheik of Mohammerah, commanded by an Arab pilot. They travelled part of the way by night, and found no difficulty at all as far as Ahwaz, and above there was still more water. The greatest difficulty was apprehended in going through the Bakinari country, but the chief received him most kindly, and would have been very willing to take a half-share in an enterprise for establishing regular steam communication. Subsequently he went to Teheran, and negotiated for a concession, asking, of course, in the first instance, for a great deal more than he was prepared to accept; but nothing came of it. He asked for an exclusive concession for a certain number of years, which the minister objected to very civilly, as he himself told him, because competition would tend to lower freights and benefit the country; and his object was not the profit to be got out of the steamers themselves, but to tap the fertile country up to Hamadan, where Major Napier told him he had seen only a few months before 80,000 tons of grain lying ready to rot, which could be purchased for 5s. or 7s. a ton. Mr. Martin Wood had asked how they were to increase the resources of Persia? There was no easier way than by developing the corn trade, and there was abundance of corn along the whole littoral, but the Government put all sorts of obstacles in the way of the trade. If there were no rainfall, they immediately put an embargo on it, and thus there was always so much uncertainty that merchants did not care to run the risk of sending ships there, not knowing whether they would be allowed to load. He believed that if the English Government supported them properly, this would not happen. The same thing went on all along the Tigris and Euphrates Valley, though that was under Turkish rule. There was a special firman authorising two English steamers, which had to carry the mails, and at times they found it very difficult to meet the trade of the country. They had enlarged the tonnage of their vessels, and lately built some flats, but the Turks would not allow them to be used, saying they were not authorised by the firman. During the late famine these vessels were of great service in bringing up seed-corn from India. The corn which was exported was all drawn from the districts close to the shore, as it would not pay to bring it a long distance, and in time of famine, the mules were first to die off. Not content with laying an embargo on the export of corn on the slightest pretext, the most ridiculous quarantine was imposed, though it was not very strictly enforced. Owing to all the obstacles placed in the way of navigation, even in the Persian Gulf, the regular line maintained by the British Indian Company had been withdrawn, as it was found more profitable to send their vessels elsewhere. The whole direct trade with England, therefore, was now dependent on vessels specially chartered, which did not carry passengers, and this was by no means so satisfactory. Mention had been made of his firm having withdrawn from Ispahan and Shiraz, which was in consequence of finding, after struggling on for about ten years, that it was almost impossible to recover the most ordinary and just debts. Of course, in all commercial transactions where there was much profit there must be some risk, but with all precautions which could be taken, in Persia the risks were

so great, that there was no satisfaction in continuing the trade. He thought the English officials might be better distributed than they were in Persia, and if there were more in the south, they would do much to help English merchants. The only help they received was from the presence of the telegraph establishment over which Colonel Bateman-Champain presided; and no one who had not been in Persia could conceive what the presence of the few Englishmen who were there engaged had done. Colonel Bateman-Champain would be able to say what difficulties he had to encounter in establishing that telegraph, but now that the Government had seen the value of it, they had established several lines of their own, which were very fairly maintained. It had been suggested that Persian steamers should be placed on the Karùn, and he had always said he would support it or anything else to develop the resources of the country. He had not much faith, however, in Persian management, and would much rather see it under an English company, in which Persians might hold shares. Along the whole of the coast there was abundance of grain, and, but for the restrictions to which he had alluded, the export might increase enormously. He should be sorry to embark capital in any railway in Persia, and if anything of the kind were attempted, it should be very light and economical, more like a tramway, to commence with. He did not grudge what Russia was doing in the north; it was very wise on her part, and as a friend of Persia he was glad to see it, but the opposition to English commerce in the south could only be due to Russian influence.

The CHAIRMAN said he was sure all present would agree in presenting a vote of thanks to Colonel Bateman-Champain for his interesting paper. The subject of it was as wide as Central Asia. With regard to what Mr. Martin Wood had said, he was unaware of any negotiations having taken place with another Government, as to the navigation of the Karùn. It seemed to him that what concerned our Government was that, in some way or other, the peaceful civilising influences of trade should be brought to bear on the region which lay between the Mediterranean and the frontier of India. All these influences were for good; every man who entered into trade wished for peace and to enjoy the fruits of his own industry. The great obstacle to advancement in Asia lay in the action, or want of action, on the part of Asiatic Governments, and the consequent insecurity of property and uncertainty in the minds of men whether they would receive and enjoy in security the fruits of their industry. In proportion as that insecurity could be removed, so would the centre of Asia be opened up. If, for a time forgetting political rivalries amongst European nations, we could in any way bring pressure to bear on those uncivilised Governments, it would be not only for our own interests, but for the honour of humanity. Let us, by all means, open up the trade for ourselves; but if we fail in doing so, and if the French came into the Karùn, let them do so. So long as we enjoyed the benefit of the most favoured nation clause, and there is freedom of trade, we may trust to the energy and enterprise of English merchants to come to the front in any part of Central Asia. But so long as the native Governments are permitted to say, you shall have only one steamer, and you shall not have a barge along with it; or, you shall not come up my rivers or improve my lines of communication; and so long as the political rivalries of civilised nations allow such an attitude to be maintained, so long will this region remain undeveloped. And so long as our civilised political rivalries continue, we shall distrust the approach one of another, and thus retard civilising and peaceful proceedings in the countries intervening between us.

Mr. HYDE CLARKE, in seconding the vote of thanks, said this subject had more than once received attention in that room, and had thus been kept before the notice of the Society and the public. Colonel Bateman-Champain had referred with some despondency to the circumstance that since the time of Captain Selby, forty years had elapsed, and nothing had been done, but looking at the altered condition of the question of the Karùn, he thought they might entertain some hope. It was attracting more and more public notice, and when this paper was published, still more hopes might be entertained of the subject entering on a practical path. It was evident to any practical man that the only way in which the resources of a country like Persia could be turned to account was by developing the means of transport. The cost of transport always entered more or less into the price of a commodity, and if the means of transport could be improved, production would be, *pro tanto*, increased. Mr. Wood, who had paid a great deal of attention to these questions, had intimated that the question of irrigation was of great importance, but he thought that must be postponed for a time. With increased facilities of communication, it might not be necessary at first to consider the question of developing the whole production of Persia; for, as Colonel Bateman-Champain had shown, the district of the Karùn and Dizful might be developed, and a large grain trade at once established. Personally, he felt very grateful to the reader of the paper for having, at considerable inconvenience, attended that evening and given them the benefit of his experience. He recollected having the pleasure of meeting him in Constantinople in 1862, when he was dealing with the difficulties of the great enterprise he was then engaged in, and it was a great pleasure to be able to congratulate him on its accomplishment. It was impossible to deny that the great difficulties to be encountered in connection with this subject were political, and that they were, in great measure, caused by the transference of the Persian Embassy to the control of the Foreign-office. They all knew that there was no

lack of zeal on the part of our officials out there, but there was an absolute want of any systematic policy at home in favour of English commerce.

The vote of thanks was carried unanimously, and the meeting separated.

SIXTEENTH ORDINARY MEETING.

Wednesday, April 4th, 1883; C. W. SIEMENS, D.C.L., LL.D., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Barry, William, J.P., Scarborough.
Cowper-Coles, C.B., 95, Wigmore-street, W.
Darby, George Frederick, 149, Upper Thames-street, E.C.
Davis, William J. Leach, The Grammar School, Maidstone.
Galloway, John, jun., Knott Mill Iron Works, Manchester.
Greenup, William Thomas, The Avenue, Cambridge.
Hansell, Robert Blackwell, Moor Oak's - road, Broomhill, Sheffield.
Harland, Arthur, 170, Stanhope-street, N.W., and The Polytechnic, Regent-street, W.
Harris, Alfred Edwin, 14, The Avenue, Sunderland.
Hawkes, Charles Samuel, Stoneleigh, Beckenham, Kent.
Hollins, William, 5, Queen's-gate-place, S.W., and Pleasley-vale.
Phillips, Charles Henry, 387, Mare-street, Hackney, E.
Pole, Thomas, 2, Beaconsfield - road, Clifton, Bristol.
Pratt, Thomas, 24, Tavistock-street, Covent-garden, W.C.
Rainger, Charles Henry, 9, Bath-place, Cheltenham.
Spruce, Samuel, Beech-house, Tamworth.
Stephens, Major Edmund, R.E., Junior United Service Club, S.W.
Swan, Henry F., North Jesmond, Newcastle-on-Tyne.
White, Arnold, Devonshire Club, S.W.
White, Robert Blake, F.G.S., 23, Anerley-park, Anerley, S.E., and Medellin, United States of Colombia, South America.
Wilson, Hugh, 9, New Broad-street, E.C., and Chesterleigh, Beckenham, Kent.
Wood, Thomas, Ebbw-vale Works, Monmouthshire.

The following candidates were balloted for and duly elected members of the Society:—

Barker, John Lees, Bowdon, Cheshire.
Biertumpfel, F. J., 138, Albany-street, N.W.
Bosanquet, Bernard, 131, Ebury-street, S.W.
Clunn, Philip Edward, 23, Regent-street, S.W.
Livesey, Montague, Boyle Farm, Thames Ditton, and Stourton Hall, Horncastle, Lincolnshire.
Ridley, Thomas Dawson, Coatham, Redcar.
Rumbelow, Harry Albert, The School House, Soham, Cambridgeshire.
Selberg, Georg Emil Carl, 195, The Grove, S.E.

The paper read was—

THE MEASUREMENT OF ELECTRICITY.

BY JAMES N. SHOOLBRED, B.A.,
Mem.Inst.C E.

By the expenditure of a certain amount of energy under different forms, such as by friction, chemically, by mechanical means, or in other ways, upon certain bodies, these become "electrified," as it is termed. That is, they develop certain properties of attraction and repulsion for other bodies, which are known as electrical phenomena. These electrical phenomena may, by the intervention of certain other substances, be made manifest at a distance from the point where the energy is applied.

The word "electricity" is employed to denote the results of this electrification; and it may be considered, therefore, as the term for the vehicle (or "mode of motion" as it is aptly termed by Prof. Tyndall) for the transference of this energy to the point at which it is desired to utilise it.

As energy is a measurable quantity, in the other different forms or conditions of matter in which it becomes apparent, such as heat, light, water, steam, gas, &c., so also is it measurable when electricity is concerned. This measurement, as in the other cases just referred to, is generally made by means of the effect rendered visible by the intervention of its carrier.

A series of phenomena of attraction and of repulsion, akin to electrical phenomena, may be produced by means of certain metallic bodies, which possess these properties either naturally or artificially, and are termed magnets; these properties are also possessed by the earth itself. These are termed magnetic phenomena; and the consideration of them and their results is embraced under the name of "magnetism."

The researches of Œrsted, of Ampère, and principally of Faraday, have shown that these magnets not merely may largely influence electric phenomena in their immediate vicinity, but also that they may actually, by induction, cause such phenomena to take place. The

results due to this double influence are known as electro-magnetic phenomena.

Since the measurement of the results of magnetic phenomena can be effected as readily as are the electrical measurements, it follows that the same facility exists respecting electro-magnetic phenomena. As almost all the so-called electric machines are, at present, constructed upon the magneto-electric system of arrangement, the question of the measurement and general consideration of their results must be based upon electro-magnetic principles; and upon these only, unless otherwise stated, are founded the following remarks:—

The measurement of all physical quantities rests upon three fundamental units—those of length, of mass, and of time. All other units can be derived from these.

In this country the fundamental units generally (though not always) used are:—Length, one foot; mass, one avoirdupois pound; time, one second of mean solar time.

In France, where the metrical system is in use, the fundamental units are:—Length, one metre (supposed to be $\frac{1}{40000000}$ of the earth's meridian); mass, one gramme; time, one second.

In each system, however, respectively, the above units are not always strictly adhered to. Thus, in the former, yards, grains, minutes, or hours may be substituted; and in the latter, centimetres, millimetres, kilogrammes, or minutes might be used, according as most convenient for the dimensions of the quantities to be expressed. In dealing with precise measurements of physical quantities, and the comparison between them, this, of course, causes much confusion, while the great advantage of some common system of units for international communication has been speedily recognised. A variety of suggestions and attempts were made to remedy this; the most important of them being those of Professor Weber (of Göttingen), of Sir William Thomson, and of Mr. Latimer Clark.

The question was not, however, taken up practically till 1861, when the British Association for the Advancement of Science, at the instance of Sir William Thomson, referred it to a committee on "Electrical Standards." The labours of the committee were long and tedious, and extended till 1873. Among its members were Sir William Thomson (chairman), Dr. C. W. Siemens, Sir F. Bramwell, Dr. Joule, Mr. Latimer Clark, and Professors Carey Foster, Fleeming Jenkin, Everett, &c., &c.; and also such distinguished electricians, now deceased, as Sir C. Wheatstone, Prof. Clerk Maxwell, and others.

The advantages offered by the metrical system for calculation, as well as by its already extended use, led to its selection by the committee as the basis of the units. But the centimetre was adopted in preference to the metre as the unit of length, as being a more convenient dimension in general calculation, and as also—since the cubic centimetre represented the volume of a gramme of water—by selecting the centimetre, the density of water became unity, which was a further advantage.

The fundamental units chosen were:—length, centimetre; mass, gramme; and time, second; and the name of the C.G.S. system was given to the whole system.

Under this distinction, this system, together with that of the "Practical" units for electrical measurements (described further on) received, in 1881, the sanction of the International Congress of Electricians at Paris; and these systems are now being generally adopted into universal use.

As with the use of a scale, common to all quantities, both very large and also very small numbers must often be represented, it is advocated in the C.G.S. system to express each number as the product of two factors, one of them being a power of 10; and also to effect this in such a way that the exponent of the power of 10 shall be the characteristic of the logarithm of the number. Thus, 1,280,000 would be written as $1{\cdot}28 \times 10^6$, and ·000128 as $1{\cdot}28 \times 10^{-4}$.

The following Table contains some of the units based upon the C.G.S. system:—

C.G.S. UNITS OF MEASUREMENT.

Fundamental Units.

Length, one centimetre; mass, one gramme; time, one second.

Derived Units.

Mechanical.

Velocity	Unit length in unit time: Centimetre / Second.
Acceleration	Rate of increase of velocity per second: In gravitation measure $= g$. g, in latitude of London, $= 981$ C.G.S. units.
Momentum	Momentum of one gramme with a velocity of one centimetre per second.

Force or Power } *Dyne* ..Force which, acting upon one gramme for a second, generates a velocity of one centimetre per second.

Work—*Erg* .....Amount of work done by one dyne working through one centimetre of distance.

Electro-magnetic.

Magnetic Pole ....A pole which, at one centimetre distance from a similar pole, gives a force of one dyne.

Magnetic Field ....The intensity of a field which acts on unit magnetic pole with a force of one dyne.

Current .....A current flowing along one centimetre of a circuit in form of a circular arc, of one centimetre radius; and exerting a a force of one dyne on a unit pole placed at the centre.

Quantity.....The quantity conveyed by unit current in one second.

Potential or Electromotive-force } The difference of the electric condition between two conductors, or two points of one conductor, when the transference of electricty, from one to the other, is proceeding at the rate of one erg of work per unit of electricity transferred.

Resistance .....A resistance such that, with unit of difference of potential between the ends of conductor, one unit of current is conveyed along it.

N.B.—The estimation of resistance actually resolves itself into a question of velocity, *i.e.*, $\frac{\text{Length}}{\text{Time}}$.

Some of the above C.G.S. electro-magnetic units being found to be inconveniently large, and others to be far too small, the following "Practical" units, for general use, have been deduced from them. As already stated, they received, in 1881, the sanction of the International Congress of Electricians, and they are now being universally adopted.

"Practical" Electrical Units.

The *Ohm* (10^9 C.G.S. units of resistance), as the unit of resistance, is that of a column of mercury having one square millimetre of section, and of a length hereafter to be determined by a commission specially appointed for the purpose.

Note.—The length is supposed, however, to be between 104 and 105 centimetres.

The *Volt* (10^8 C.G.S. units of electromotive force), as the unit of electromotive force.

Note.—This corresponds nearly to that of a Daniell's cell.

The *Ampère* (10^{-1} C.G.S. units of current), as the unit of current; which is the current produced by one volt through one ohm.

The *Coulomb* (10^{-1} C.G.S. units of quantity), as the unit of quantity of electricity; which is defined by the condition that an ampère yields one coulomb per second.

The *Farad* (10^{-9} C.G.S. units of capacity), as the unit of capacity; which is such that one coulomb in a farad shall give one volt.

Or, to quote the words of Sir Wm. Thomson (the chairman of the British Association Committee which settled the C.G.S. system of units above referred to), when explaining the practical units to the Congress:—"The volt acting through an ohm gives a current of one ampère, that is to say, one coulomb per second; and the farad is the capacity of a condenser, which holds one coulomb, when the difference of potential of its two plates is one volt."

The following were also suggested by Dr. C. W. Siemens, in his inaugural Presidential address at the British Association meeting, 1882, to be added to the above units:—

The *Watt* (10^7 C.G.S. units of power), as the unit of power; being the power conveyed by a current of one ampère in one second through a conductor, whose ends differ in potential by one volt.

The *Joule* (10^7 C.G.S. units of work), as the unit of work, or heat, being the heat generated by a watt in a second.

To endeavour to illustrate this connection, or rather the dependence which the derived electro-magnetic units have upon the fundamental ones, the following illustration may serve:—If, for instance, a coil of wire be made to rotate in the magnetic meridian, and in doing so to cut the natural lines of force, an electric current, induced by the magnetism of the earth, will then be set up in the coil, and this current may be made manifest by the deflections of the needle of a galvanometer placed in circuit. Similarly, this may also be evidenced by the substitution of a magneto hand-machine for the above coil; and by means of this artificial magnet, to induce an electric current in the rotating coil.

Here are two examples, in which the movements of a mass of copper wire, through a certain length, in a given time, can be directly connected with the generation of an electric current. Certain proportions between these various elements can be ascertained, so as to

obtain, with the first-named three properties, a measure of the effect of the current, and of its various functions respectively.

In the construction of instruments for the generation and measurement of electric currents, great advantage is taken of the inducing action of magnets upon coils; of the effect of the passage of the electric current through a coil upon a magnetic needle in its vicinity; and of the result of electric currents of different intensities upon each other, in their passage through conductors in the form of coils.

The evaluation of the electrical energy of a supply depends upon the exact measurement of two factors—the amount of the supply and the pressure under which it is given; or, in other words, the quantity of the current and the electromotive force.

The product of the current expended, in ampère seconds, or of this amount of quantity expressed in coulombs, by the electrical pressure of the same, expressed in volts, gives therefore the electrical energy expended, or the power of the supply.

The electrical energy is, therefore, represented by the product of volts × ampères × time; or, by the product of volts × coulombs; or, expressed algebraically, $W = E\,C\,t = E\,Q$.

The following are the equivalent expressions for the same amount of power, only expressed in other terms; some of which may, perhaps, be more familiar:—

Rate of expending Energy.

1 volt-ampère =
- 10^7 ergs per second.
- 1 watt.
- $\frac{1}{1 \cdot 35}$ foot-pounds per second.
- $\frac{1}{9 \cdot 81}$ kilogrammetres per second.
- $\frac{1}{736}$ force-cheval (French horse-power).
- $\frac{1}{746}$ horse-power.

The Board of Trade suggest, in the provisional orders for the supply of electricity now pending, that the unit of price to be charged should be based on "the energy contained in a current of 1,000 ampères flowing under an electromotive force of one volt during one hour;" or, in other words, the unit might be put as 1,000 volt-ampère-hours. The ampère-hour is another way of saying 3,600 coulombs of quantity of electricity supplied. It may also be of interest to state in other, and perhaps more conventional, terms, the equivalent of the amount of work implied in the above unit.

Work done, or Energy expended.

1,000 volt-ampère-hours =
- 10^{10} erg-hours.
- 3,600,000 volt-coulombs.
- 3,600,000 joules.
- 1,000 watt-hours.
- 2,645,000 foot-pounds.
- 366,840 kilogrammetres.
- 1·35 force-cheval-heures.
- 1·34 horse-power hours.

Put in terms more in accordance with actual practice, the above unit might mean the supply for one hour of a current of 10 ampères with an electromotive force of 100 volts; or of a 5-ampère current with an E.M.F. of 200 volts; or again, a 10-ampère current at 200 volts for only half-an-hour; and so on, provided that the product of the three factors is always 1,000.

To arrive at a due evaluation of the supply of electric energy, it is evident that the measurement of each of these two factors (in volts and ampères respectively), should be effected either separately or combined; and also that a continuous and cumulative record should be kept of the supply as it proceeds.

Many instruments exist for the measurement of the above elements, at any particular time; but without any means of continuously recording such measurements. These evidently, except under certain conditions, cannot comply with the commercial conditions required for ascertaining the amount of supply. It is only, therefore, instruments furnished with means of continuously integrating, or recording the successive progressions of the supply, or instruments to which such recording apparatus can readily be attached, that come properly within the scope of this paper.

To measure with completeness for commercial purposes, a supply of electricity will entail, therefore, a continuous record of each of the two elements just referred to, current and pressure, either separately or combined. In the supply of towns, however, the question for the consumer may, and will most probably, be much simplified, by causing one of these elements, that of pressure, to remain constant; since it is very likely that a constant standard pressure of supply will be fixed by the Government in granting the several provisional orders. If so, it then becomes the duty of the suppliers to keep up to that pressure under penalty; and instruments for recording such pressure

will have to be installed where required, and placed under proper supervision.

For the customer, however, it will then generally suffice to have an exact record of the quantity only of his individual consumption of electric supply.

It has been thought advisable to precede the description of the recording or registering instrument, which alone are "meters" in the commonly accepted sense of the word, by an enumeration of some of those non-recording instruments which are in more general use; since they suffice for present exigencies. This short descriptive enumeration is even almost necessary, since most of these instruments, by the addition of some recording apparatus or appliance, by which the element of time can be integrated, may be made to enter into the class of registering meters. Indeed, some of them already possess their representative in this second class, or else have given rise to some modification, which has complied with the requirements in the latter case.

Thus, any current or ampère measurer may be converted into a record of quantity, or a coulomb-meter, by the integration of the time during which the current has flowed, and, similarly, any power or volt-ampère measurer may become a register of work done by means of the addition of the elements of time. Again, volt or pressure measurers will always be required in any case where a check is required upon the actual difference of potential, or electromotive force of the supply; and this may arise from a variety of causes.

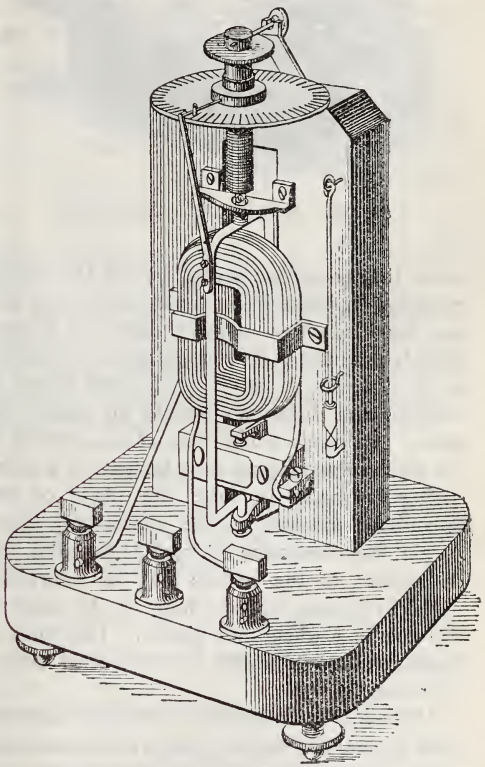
Non-Registering Instruments. Current Measurers.

Siemens's Electro-dynamometer consists of a fixed coil, and of a movable coil suspended by a thread and a spiral spring, the normal position of the latter being at right angles to that of the former. When a current is sent through the two coils in series, the movable coil is deflected; this deflection is counteracted by torsion of the spiral spring, the amount of such torsion (indicated by a pointer on an index-dial) being proportioned to the square of the current strength.

Obach's Tangent Galvanometer has a movable ring round a horizontal axis. If the ring is vertical, the needle tends to turn on a vertical axis, as in the ordinary tangent galvanometer (the opposing force being the horizontal component of the earth's magnetism); if, however, the ring is placed horizontally, the needle turns round a horizontal axis, or dips (the opposing force being the vertical component of the earth's magnetism). The effect of the intensity of the current upon the needle may therefore be varied with the inclination of the ring. With the ring in any fixed position, the current strength is proportional to the tangent of the deflection (as in an ordinary tangent galvanometer).

Cardew's Low-resistance Galvanometer is based on the principle of finding the intensity of an unknown current by balancing it against one of known strength, and thus ascertaining

Fig. 1.



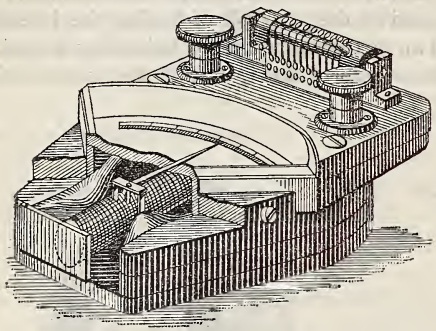
Siemens's Electro-dynamometer.

the relation between the two. It consists of two coils, a thick wire one (for the unknown current), and a thin wire one (for the standard one); both are wound on the same bobbin, but are insulated from each other. A magnet, with needle-pointer, is pivoted in the centre of the bobbin, and its deflections are counteracted by the insertion of known resistance.

Ayrton and Perry's Am-meter. — This instrument is made in several forms. In its original form it consists of a permanent magnet of horse-shoe form, with a needle-armature

fixed between its pole-pieces. These are made of such a shape as to ensure that the deflections of the needle shall be directly proportional to the intensity of the current causing them; hence a knowledge only of the constant of each instrument is required when using it. Further-

Fig. 2.



Ayrton and Perry's Am-meter.

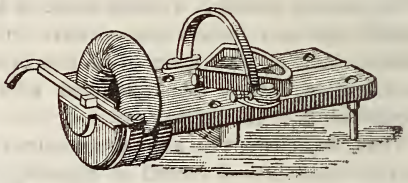
more, the coil of wire, through which the current passes, is in some instruments divided up into ten strands, which may, by means of a cylindrical commutator, be coupled up in "parallel" or in "series;" as it is desired or not to magnify the deflection tenfold for small currents. In cases where loss of magnetism in the permanent magnet is to he feared, a spiral spring is made to take the place of the horse-shoe magnet as the controlling force. Again, where extreme delicacy is required, the deflections of the needle may be magnified tenfold or more, by attaching to the shaft of the needle a wheel and pinion. This form of instrument is adapted for use with strong currents.

Deprez's Galvanometer consists of a horse-shoe permanent magnet, with a solid armature-needle, of peculiar "fish-bone" form, and index-pointer, pivoted vertically, placed between its poles, and a coil of the wire, which carries the current to be measured, laid within the horse-shoe. A table indicating the value of the several deflections of the needle has to be used.

Sir William Thomson's Current Galvanometer.—This instrument, together with its fellow one, for the measurement of the difference of potential, have been termed "graded galvanometers." They are designed so as to permit of a very wide range being obtained with each respectively; this being effected by varying the intensity of the magnetic field in a known ratio, and comparing with it the unknown current.

The present instrument consists essentially of two parts: 1st, a coil of thick wire, through which the current to be measured is allowed to pass, it being fixed upright at the end of a wooden platform, with about one-half only of the coil projecting above it; and, 2nd, of a "magnetometer." This last consists of four short steel magnets (constituting the "needle") mounted in a frame on a vertical axis, with a long aluminium pointer attached, and enclosed in a quadrant-shaped box, with a glass cover, and a silvered glass mirror bottom (in order to counteract any effect of parallax while reading the scale of tangents, to which the instrument is graduated).

Fig. 3.



Sir Wm. Thomson's Graded Galvanometer.

In order to increase the directive force of the needle, when required, a semicircular permanent magnet of hard steel, and of known intensity, may be fixed upright on two arms projecting from the magnetometer, behind the apex of the quadrant. The magnet stands over the needle, with its magnetic axis in the horizontal plane through that of the needle.

The magnetometer is made to slide along a groove in the wooden platform in front of the fixed coil, and in a direction at right angles to it, the axis of the magnet and also of the needle (when at rest) being parallel to that of the coil; while the aluminium pointer, when at zero, which is the centre of the scale, lies in the same direction as the groove, or at right angles to the coil.

The range of sensibility obtained by varying the extreme distance along the groove of the magnetometer from the coil is about fifty-fold; while by removing the magnet, and leaving the needle under the influence of the earth's force alone, a further sensibility of fifty times greater can be obtained.

Pressure Measurers.

Ayrton and Perry's "Volt-meter" is in principle and form like their am-meter, and it has, like it, several similar modifications. The

essential difference between the two instruments is that the thick wire coil of the ammeter is here replaced by a thin wire coil, with the connections to its ends so arranged as to measure the difference of potential between the points desired.

Sir William Thomson's "Potential" Galvanometer differs only from his "current" instrument, already described, in the use of a thin wire coil (of German silver of about 6,000 ohms resistance), instead of a thick wire coil; and in the change in the connections to suit the present object.

Siemens's Torsion Galvanometer consists of a bell-magnet, suspended between two coils of fine wire by means of a thread and a spiral spring. The deflections of the magnet under the current are counteracted by means of the spring, as in the electro-dynamometer, only that the angles of torsion are here proportional simply to the intensity. Certain resistances can also be added by which the sensitiveness can, by means of the insertion of a plug, be increased tenfold.

Power, or Energy Measurers.

Ayrton and Perry's Power-meter consists of a thick wire coil through which the main current passes, and of a fine wire coil on a shunt, which is suspended within it. The axis of the two coils are parallel, and the passage of a current tends to deflect the suspended one. Since the thick wire coil measures the intensity of the current, and the thin wire one its electromotive force, and as the deflection of the latter is the product of the two, therefore the amount of that deflection is the measure of the power, or energy, of the current.

Modifications of this instrument, with or without a commutator, or with a wheel and pinion arrangement, are also made.

Siemens's Watt-meter.—This instrument is constructed on the same principle as the electro-dynamometer. The two coils are, however, kept distinct from one another, with separate terminals to each. The fixed one, of thin wire, on a shunt, measures the electromotive force; while the movable one has the main current passing through it. The resulting position of the latter coil is due directly to the intensities of the two currents; that is, to the power developed. This product, of volts × ampères, is watts; hence the name of the instrument. The angle of torsion of the index-pointer gives the watts directly, and with the knowledge of the particular constant.

Resistance Measurers.

Although measurements of this class are generally carried out by means of a galvanometer, a set of resistance coils, and a Wheatstone bridge (therewith balancing the unknown resistance by means of one of a known amount), yet amongst the instruments exhibited is the following one. It is intimately connected with some of those already described, and its internal arrangements are based upon one of the fundamental laws of electricity, that of Ohm; which states that resistance $= \frac{\text{E.M.F.}}{\text{current}}$.

Ayrton and Perry's Ohm-meter consists of two coils: a thick wire one for the main current, and a thin wire one on a shunt for the electromotive force. Both are fixed with their axes at right angles to each other. A needle is acted upon by the currents flowing through each, and as these are at right angles to each other, the resulting deflection represents the ratio $\frac{\text{E.M.F.}}{\text{current}}$ *i.e.*, resistance; while in the power-meter the deflection is caused by the product of current × E.M.F.

In all these different instruments, devised by Professors Ayrton and Perry, the deflections are caused, by duly proportioning the parts, to be directly proportional to the measurements sought for in each case.

Registering Instruments.

These may be divided into two clases—1st, quantity, or Coulomb-meters; and, 2nd, energy, or work-meters.

1. Quantity, or Coulomb-meters.

These, again, are separated into those based upon, *A*, *electrolytic* action, and those which are, *B*, *mechanical* in principle.

A. Electrolytic.

Edison's Current-meters.

These are based upon electro-deposition of metal, due to the action of a known fractional part of the total current. The weight of the increments is ascertained periodically, and from it the total quantity of the current which has passed during the interval is deduced.

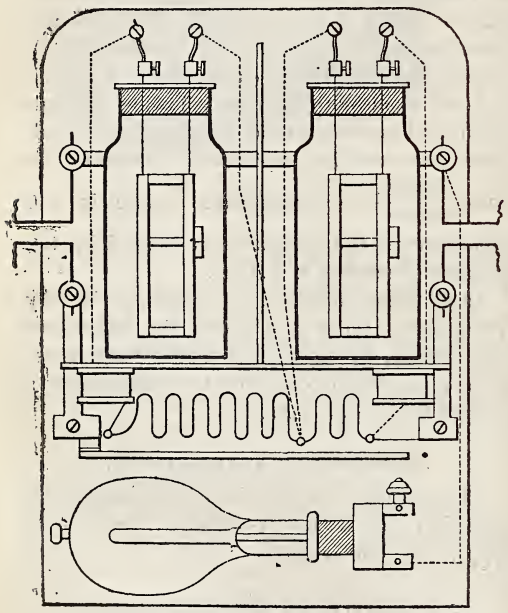
The metal now generally used consists of plates of amalgamated zinc, immersed in a solution of 90 parts of sulphate of zinc and 100 parts of pure water.

In the form of meter for commercial use, two cells are placed as a check against one another; one, termed the "monthly cell,"

receiving four times the current of the other, which is known as the "quarterly cell."

In order to prevent the temperature of the liquid in the cells falling so low as to freeze, a connection is made, by means of a long thin strip of brass and steel rivetted together, to an incandescent lamp, which is thereby lighted, and raises the temperature as required. It is only when the temperature falls to 42° Fah., that this tongue is sufficiently depressed to form contact, and so to light the lamp. On the temperature rising the tongue rises, and the lamp is extinguished.

Fig. 4.



Edison's Current Meter.

Experience shows that electro-deposition, to give a true and reliable record, should not be forced or overworked in its action; and that the plates should not in their daily duty be required to do more work, or be longer in action than they are intended for by their superficial area. In practice, about 75 per cent. only of the nominal work should be required of them. It appears to be the custom to design the duty of a meter for three hours burning of each lamp per night. Thus, a 25-light meter would have its plates designed for 75 lamp-hours per night. As just stated, it is not advisable, in practice, to exceed 75 per cent. of this amount. However, it is seldom found that the whole of the lights are used for the entire of the time allotted to each; and, if this were so, it would merely require a larger meter to meet the case.

At the present moment, it is understood that over three hundred meters on this principle are in use in New York.

Sprague's Meters.

These instruments are based upon electro-deposit up to a certain point; *i.e*, when the intended quantity of metal, whether copper or zinc, has been deposited on the plate. The current is then reversed, and the metal gradually dissolved again until the primary condition of the plate is reached; when, by another reversal of the current, deposition again commences. Each reversal of the current is recorded by a mechanical counter and a train and wheels.

Not much practical experience has so far been obtained with these meters; but what has been done tends to point out that the mechanical operations involved in the reversals of the current, and in their registration, absorb a large amount of power.

B. Mechanical.

Hopkinson's Current-Meter.

This instrument consists of a thick wire coil, in the form of a solenoid, through which the current passes to be measured. The iron core of this solenoid revolves with its central shaft by the action of the armature of a small dynamo machine, placed at one end of the shaft.

The core of the solenoid is in two parts; the lower is fixed to the shaft, while the upper is movable, being attached to a governor-ball arrangement, and sliding up and down the shaft in accordance with the variations in the rotation speed of the shaft. A shunt current passes through the dynamo and its armature, then up through the lower or fixed portion of the core, and (by contact only) to the sliding part, and thence to the framework of the apparatus.

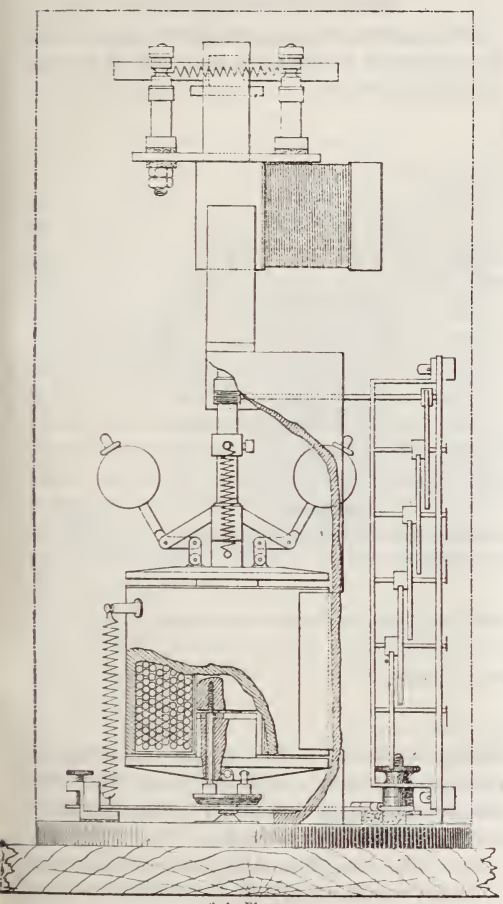
If the movable core be lifted, owing to the speed of rotation by the action of the governor-balls, this circuit is broken, and the shunt current through the dynamo interrupted. Whenever a current to be measured passes through the coil, attraction, by means of its casing, takes place between the fixed and the movable parts of the iron core.

This magnetic action, which is proportional to the square of the current, tends to keep the two parts of the core together and in contact; while the centrifugal force of the

governor-balls, which is proportional to the square of the speed of revolution, tends to break the contact by lifting the movable part. These opposite forces will, in working, balance one another, and the result is that the system revolves with a velocity proportional to the current through the coil.

As the revolutions of the shaft are transmitted continuously by a train of wheels to a set of index dials, a record is thus kept of the quantity of the current that has passed.

FIG. 5.



HOPKINSON'S CURRENT-METER.

BOYS'S QUANTITY OR VIBRATING METER.

This instrument is based upon two well-known principles. 1. The force acting on the armature of an electro-magnet, in any position, is proportional to the square of the current. 2. The square of the number of vibrations, say, of a pendulum, is a measure of the controlling force.

Therefore, if the controlling force under which a body vibrates is due to the action of an electro-magnet on its armature, the square of the number of vibrations in a given time is a measure of the square of the electric current. In other words, the rate of vibrating is a measure of the strength of the current; and the number of vibrations is a measure of its quantity.

The exact form and nature of the meter may vary in many details. The one now shown (Fig. 6, p. 506) consists, primarily, of an electro-magnet (the upper one), through the coils of which passes a portion of the main current to be measured. This magnet is placed horizontally, and a vertical rocking shaft stands between its poles. This shaft has fixed on it a soft iron armature, rounded at the ends, and free to move in the horizontal plane between the poles of the electro-magnet.

The intensity of the attraction between the poles and this armature determines the rate of vibration; which, as above stated, is a measure of the strength of the current. Each vibration is itself recorded by means of an escapement, a train of wheels, and a set of index dials; and the number of vibrations thus registered becomes a measure of the quantity of the current. To add to the momentum of the vibrating body, two long arms, weighted at the end, are attached to the lower part of the vertical shaft.

In order, likewise, to prevent the vibrating armature from gradually coming to rest, it is arranged that, when the vibrations fall below a certain limit, by making contact, a portion of the current is sent round the coils of a second or "impulse" electro-magnet (placed underneath the "controlling" magnet), and which has an armature of a suitable form fixed on to the same shaft that carries the armature of the upper magnet. The extra motion thus given to the shaft, by the attraction of the lower armature, affords the necessary impulse to the vibrating armature when required to do so.

LANE-FOX'S QUANTITY METER.

In this instrument the entire of the current of supply is passed through the coils of a solenoid; the movable core, or plunger (the degree of insertion of which within the solenoid depends upon the intensity of the current) is made pendant from one end of a beam or balance. From the other extremity of the beam hangs a plunger, in the form of an inverted cone, which in its position of rest fills up completely, with the base of the cone, a small

vertical water-pipe, the water being constantly supplied from a small cistern above.

The result of the passage of an electric current through the coils of the solenoid is to suck the core or plunger deeper in, and in doing so the conical water-plug is lifted, and its diameter at the orifice of the pipe being diminished in consequence, water escapes down the pipe. The amount of this water, being directly dependent upon the intensity of the current, becomes a measure of its quantity. A cistern is provided for this overflow; and when it becomes full, it is automatically emptied. These successive operations of emptying are recorded mechanically by a train of wheels. By this means a record is kept of the quantity of the supply.

F. H. Varley's Meter.

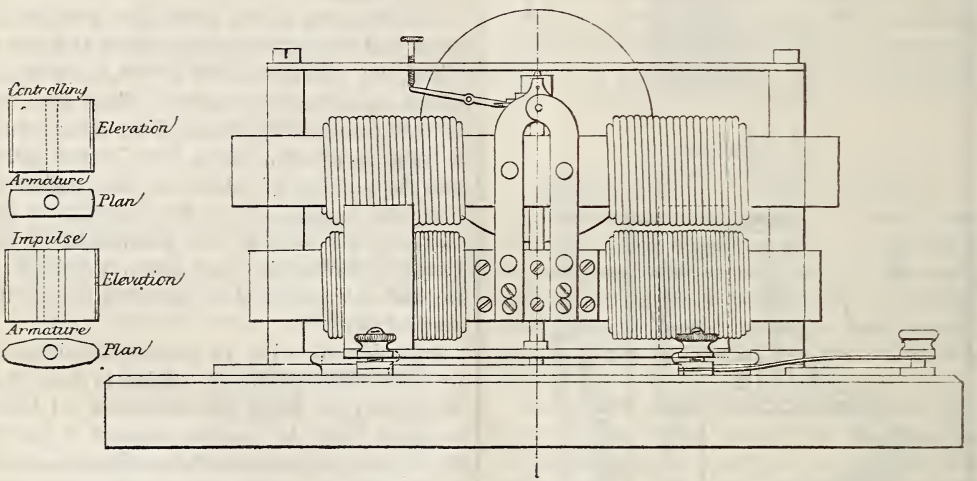
This meter is based partly upon electric and partly upon mechanical principles, the successive increments of depositions being made visible by a pointer on a curved index; and the several reversals are understood to be alterations in the mechanical direction and not in that of the current (as in Sprague's meters). The exact particulars of the arrangement, as exhibited, are not at present available.

2. Energy, or Work-meters.

Boys's Energy-Meter.

This instrument consists of two parts—1st, the indicator of energy; and, 2nd, the integrating apparatus.

Fig. 6.



Boys's Quantity-meter.

1st. In the indicator of energy, a balanced beam has from one end suspended a counterweight, and from the other a hollow solenoid, free to work up and down into two other solenoids. The movable solenoid is wound with a considerable length of fine wire; in the upper half in one direction, in the lower in the opposite (this is to render it independent of any magnet which may be placed near to it). This solenoid constitutes the high resistance shunt which measures the E.M.F. The two fixed solenoids are wound with thick wire, and convey the main current.

The result of the action of the fixed and the movable solenoids on each other is a force proportional to the product of the two currents, that is, to the energy expended; but the external evidence of this is the inclination of the beam, and this inclination, or rather the tangent of the inclination, is proportional to the energy being expended.

2nd. The recording apparatus consists of a cylinder, which, by means of a mangle-motion, is made to reciprocate backwards and forwards by clockwork, and during its passage in each direction the cylinder is made to bear alternately against one of two tangent wheels, each free to be inclined in its direction of travel: both are fixed on the same swivelling frame, but only one of them bears at the same time against the cylinder.

This frame is free to be inclined from the vertical in correspondence with the inclinations of the beam above mentioned.

The effect of this inclination of the tangent wheel is to cause the reciprocating cylinder to rotate, the speed of such rotation being proportional to the tangent of the inclination of the wheel, which is likewise proportional to the tangent of the inclination of the beam; that s, to the amount of energy expended. The path of the tangent wheel on the reciprocating cylinder, when not inclined, is simply a straight line lengthways along the cylinder, and no rotation is caused; but when, owing to the inclination of the wheel, the cylinder rotates, the wheel-path becomes a spiral.

The rotations of the cylinder are transmitted to a train of wheels and registered; thus giving a record of the amount of energy expended during a given time.

Deprez's Energy-meter.

This instrument consists of a thick wire coil, movable upon its axis, which passes through its centre of gravity. This axis-shaft is set upon two knife-edges, insulated from each other, and communicating respectively with the coil; and with a metal bar having a curved, quadrant-shaped head, which dips into a mercury cup, and thus forms connection with the main current. The shaft also carries, projecting downwards, a pendulum rod, the bob of which is intended to cause an antagonistic force; while the extension, upwards, of the rod forms a pointer, with a scale fixed on the frame of the apparatus. On the frame there is also a fine wire coil, on a shunt, fixed so as to surround the movable coil.

The deflections on the pointer are therefore due to the product of the intensity of the current and to its electro-motive force; that is, to the power developed.

The readings of this instrument may be integrated, either by a Deprez rotating disc and ball integrator; or by one designed by Abdank (of Cracow), having a travelling cylinder and tangent-wheel arrangement, somewhat similar to that of Boys.

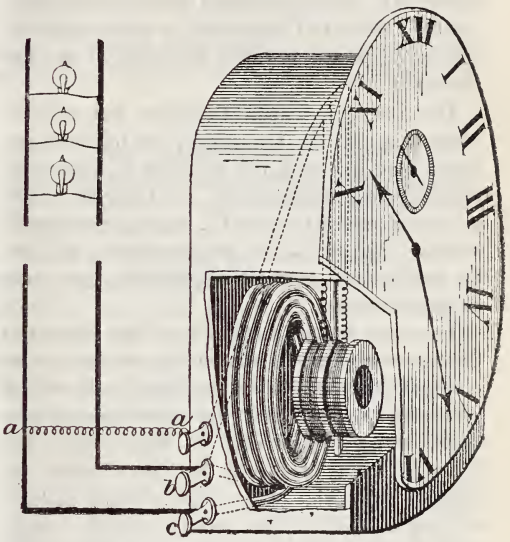
Ayrton and Perry's Erg-meter.

This instrument is but a further development or sequel to their power-meter, by the addition of apparatus which integrate and record continuously the time during which the electrical energy has been imparted, as well as the variations in its amount. By this means is preserved a record of the entire work done, or of the total electrical energy supplied.

As in the power-meter, two coils are here made use of. There is a thick wire one on the main circuit, to measure the amount of current; and a thin wire one on a shunt, joining the ends of the main circuit, to measure the difference of potential, or electromotive force, of the main circuit.

In the arrangement, as here shown, the thin wire coil, of, say, one 1,000 ohms resistance, simply replaces the pendulum bob of a clock. The wires from each end of the coils pass up the sides of the pendulum rod, and on to the binding screws A and B, which can be joined to the supply and return cables of a house, or machine, or a system receiving electrical energy.

Fig. 7.



Ayrton and Perry's Erg-meter.

In the immediate vicinity of the fine wire coil, fixed to the clock case, and parallel with the plane of the pendulum path, is fixed the thick wire coil, which forms part of the main circuit, and has a very small resistance.

The effect upon the thin wire coil of its repeated passages in front of the thick wire coil is to cause a certain pull or attraction upon its motion—either of acceleration or of retardation, according to the direction of the coiling. This action, in addition to the ordinary action of gravity upon the pendulum, will keep constantly adding to or retarding its rate of motion, in proportion to the electrical power of the circuit. This pull is the product of the magnetic moments of the two coils, and therefore is proportional to the product of the current and the electromotive force.

The effects of these repeated accelerations

or retardations upon the progress of the clock keep constantly accumulating, and their total amount can at any time be detected and ascertained by observing the amount of loss or gain which the clock has experienced. As the rate of loss or gain in the clock due to different amounts of electrical power has been previously ascertained, this knowledge of the total retardation or acceleration upon the clock is, in fact, a record of the total amount of electricity energy which has been expended, or of the work done, since the last observation of the clock.

It is probable that the supply of electricity in a town will be carried out at a certain defined standard pressure or electromotive force, which will be guaranteed to the consumer; and to assure the fulfilment of this condition, special steps will be taken by the local or other authority.

The consumer need therefore but concern himself as far as the supply he receives and has to pay for, with the quantity of electricity which he has made use of. In fact, the meter he makes use of to record it may be a coulomb-meter. The work, or energy-meters will not be needed for general application, but only in special cases.

The brief review just made of the subject of the measurement of electricity, as well as of some of the instruments employed in it, will, it is hoped, tend to show that measurement of a very precise nature can be made; more so, indeed, than perhaps in any branch of physical science. Also, that a large number of very effective instruments already exist; and that, even in the class of registering instruments, or "meters," much has already been done, and to which additions are being made almost daily.

DISCUSSION.

Professor W. Grylls Adams, F.R.S., said that, although called upon by the Chairman to open the discussion on this interesting subject, he was scarcely prepared to do so, as he had only just arrived from a long journey, nor was he prepared to discuss the numerous points brought forward in the paper. The first part dealt with the important subject of the theoretical, or C.G.S. system of units, and their relation to the practical units, which were so clearly put before the public by the Chairman, at the meeting of the British Association at Southampton. Mr. Shoolbred had passed rapidly in review the various instruments for measuring currents, electromotive-force, and electrical energy; but before much could be said about them, they required further trial and comparison with one another. Of course every inventor was persuaded of the merits of his own instrument; but there had not yet been a sufficient comparison made between them by the same person to enable any definite conclusion to be come to as to which was the best. One important point was economy; a simple instrument would have the preference over another which might be equally effective but more complicated. If these instruments were to be used by every consumer, it was a matter of great importance that they should not be unnecessarily expensive.

Mr. R. Hammond, as one who was engaged in the commercial development of electricity, felt that the best thanks of the Society were due to Mr. Shoolbred for the able manner in which he had treated the subject. It seemed to him, the greatest problem before the scientific world was how to measure the electric current. When an endeavour was made to get the inhabitants of a town to adopt electric lighting, the one great objection constantly put forward was, how was it to be paid for? In old days, probably every one went to bed at the same time—when it got dark; but people's habits differed very much in that respect now, and they said they did not want to pay so much a-year, but in proportion to the light they made use of. Therefore some method of measuring electricity, without consuming current in doing so, was one of the greatest problems of the age. However gas might be improved, it could never be made to burn without taking oxygen from the air, and giving back poisonous gases; and on that account alone, though electricity might cost four or five times as much, many people would prefer it on the score of health and comfort. In the early part of the paper, Mr. Shoolbred had reminded them of the names given to the tools used in electric science, and he thought this very useful, for many persons were not yet familiar with them. At one time, no doubt, the division of the day into hours, minutes, and seconds seemed equally abstruse, and was not readily followed, but immense advantages had been gained by the adoption of these terms, and no doubt before long people would become equally familiar with ohms, farads, and coulombs. He looked at these instruments with great interest, but he did not think any of them would meet the demand. When they came to distribute 60,000, or six millions of lights in London, which was about the number of gas-jets, something more simple would be required. They were but the rudimentary instruments, out of which the tools of the future would have to be made. They wanted something as simple as a gas-meter before they could compete with the twenty millions sterling invested in gas in London. He hoped, however, that out of some of these instruments would come something which would enable them to answer the question how they were to charge their customers. As a member of the public, he would recommend electricians, if they could do so, to introduce a unit

equal to a thousand feet of gas, which might be called a "Siemens;" but whatever was the name adopted, let electric light companies be able to make charges comparable with those made for gas.

Mr. F. VARLEY described the capabilities of his meter, and said he regretted he could not fully explain the principle and mode of action, owing to the foreign patents not being yet obtained. This meter was intended to give six months' reading for 100 incandescent lamps of the Edison pattern, assuming they took ·7 ampères per lamp; and the hand would show, in hundreds of thousands of coulombs, the amount of current which passed. When the man took the state of the meter, he reversed a switch, and it went back again. In Sprague's electrolytic meter there was a reciprocating action, by which, when one plate became heavy, it descended and reversed the action, and the fault alleged was, that a considerable amount of current was absorbed in the mechanical action, which gave no record; but if this loss were spread over six months, it would be inappreciable; and that was the system on which he worked. He could obtain a record, either in volts or ampères, and there was also an energy-meter, formed by a combination of the motions derived from the volt-meter and ampère-meter. He agreed with Mr. Hammond that it was of great importance that meters should be simple, and that all sources of error should be reduced to a minimum; but the mechanism of this was as simple as possible. What was wanted in a meter was a self-recording apparatus to show what was going on; that in fact, the current should write a journal of its proceedings. In the volt-meter, which he hoped soon to be able to describe fully, there were two actions—one of which would give the aggregate amount of work done, and the other all the variations which took place; so that, if the current increased or decreased, it would all be shown on the diagram as in a recording barometer. He fully appreciated what Mr. Hammond had said with regard to gas, and his desire to have a unit which should represent a thousand feet of gas; but he would ask if any one in that room could state the amount of light which could be obtained from a given amount of current? He was at present engaged on experiments in this direction, and had already obtained some remarkable results from flexible carbons with very small potential; in fact, with four ampères and a potential of forty volts, he had obtained an arc giving a light of five hundred candles.

Mr. BLAKESLEY said at the present time there was 80 provisional orders undergoing incubation in the genial atmosphere of the Board of Trade, to grant to limited companies a more or less practical monopoly of the distribution of electricity; and it was therefore of the utmost importance to the public to know something about electric measurements. It was not at all wonderful that companies should seize every advantage they could, but it did seem strange that the Board of Trade should meet them more than half way; and there was one flaw in the model clauses which had special reference to the subject of this paper. They were told that electric energy was measured by the E.M.F. × time × quantity; that the quantity would have to be measured in one of these meters, and then to be multiplied by what was to be called the standard pressure or potential; but this pressure was to be allowed to vary at different times of the day. The companies were going to integrate the time, and multiply that by a certain current which would be the maximum current a man could ever want, and that again by the standard potential, which might have two values in the same place on the same day. It appeared to him the authorities should insist on the measurement of quantities, and also on a certain standard of potential being maintained. Nothing had been said about the mode of measuring alternating currents, but he did not think it advisable that such currents should be allowed.

Mr. C. V. BOYS, said there was not time for him to make more than one or two remarks on the main features of his instruments. Mr. Hammond had referred to the complication of the energy-meter on the table, but it was only fair to say that that was made from the first drawings ever prepared, and it was hardly likely that such an instrument would be as simple as it might be. The one point of importance in connection with both the energy-meter and the current-meter was that there was no possibility of tampering with them by magnets. He had done his best to make them both entirely independent of any magnetic field in which they might be placed. In the current-meter, the only movable part made of iron was entirely enclosed in iron, which would shield it from the action of any external magnetism. In the energy-meter, the only movable part which could be affected had an equal number of turns in opposite directions, so that any magnetic effect would be neutralised. It was true that if the field in which the instrument was placed was suddenly changed, as by the insertion of a magnet within the case, its indications might be affected; but it would be just as easy to drive a poker through the whole affair, which would also affect it.

Mr. W. H. PREECE, F.R.S., speaking as one of the disciples of electricity, ventured to say that whenever a demand had been made on electricity to do anything, it had always responded to it, and if householders did require apparatus on their premises as simple as a gas-meter to record what was going on, he was quite certain it would be supplied. There were certain instruments on the table which, compared with gas-meters, looked rather complicated; but he should like to ask if there were six men in the room who could describe and explain a gas-meter; and if they could, whether they would be kind enough

to compare the construction of a gas-meter with that of one of the proposed electric meters. His own experience was that, in its principle and construction, a gas-meter was more complicated than anything which had been brought forward that night; and if the question of measuring electricity was to be overcome by simplicity of mechanical arrangement, he was sure they would be produced in a way which would far surpass anything now used by gas companies. Unfortunately, there had not yet been much experience of these things, and he doubted if any one else present could speak of having measured electricity by meter. For many months at the Post-office, however, they had had a portion of the premises illuminated by electricity in a way which had given the most perfect satisfaction, both as to its efficiency, healthiness, and comfort; and they had been measuring it by means of meters, in order to arrive at some conclusion as to the practicability of those instruments. They found that in practice currents of electricity could be measured with an exactitude quite equal to that of gas; the error being under 2 per cent., and they had been tested by the most skilled electricians. He rather went with Mr. Hammond in some of his observations, and he must say that within the last few days he had been negotiating a mode by which lighting might be paid for, not by measuring the quantity of electricity consumed, but by the measurement of the amount of light given as compared with that given by a thousand feet of gas. What was supplied and used was light, and what people wanted to pay for was light. A thousand feet of gas gave a very convenient standard, and if the electric light companies could only formulate some plan by which they would charge accounts for the light supplied, he believed the public would be more ready to use it than if they were charged per volt-ampère, or any other measurement which a few understood, but the majority did not. The most interesting subject was, not how electricity was to be measured, but how was it to be paid for. Mr. Boys's instruments were perfect of their kind, and Dr. Hopkinson's instrument for measuring the quantity of electricity passed into a house, though very little known, was one of the most perfect things he had ever seen. Why he objected to pay for electricity, was because he believed with Mr. Varley they did not know how much light it would produce. If they agreed to pay 7d. per 1,000 volt-ampère-hours this year, the probability was that next year such improvements would be made, that the same energy which now produced 200-candle power, would then produce 2,000, and it was absurd to restrict oneself to a certain payment for a thing which was in such a variable state of improvement. Mr. Blakesley had referred to some clauses in some supposed Board of Trade Provisional Order, which would allow of variation in the electric pressure; he did not know to what he referred, but it could not be to the final clauses issued by the Board of Trade, for they were not yet published.

Mr. BLAKESLEY said he referred to the clauses issued in February.

Mr. PREECE said those clauses were not issued by the Board of Trade; they were prepared by some of the companies, as drafts to be sanctioned by the Board. It would be found when the Provisional Orders were issued—which would probably be that week—that a fixed standard pressure would have to be maintained during the whole twenty-four hours.

Mr. SHOOLBRED, in reply, said the only point he desired to touch upon was the important one raised by Mr. Hammond. In several of the Provisional Orders sent in, especially on the part of local authorities, there was a distinct provision for a payment for so many candles of light; and in some cases it was distinctly provided that it should not exceed by so much the price allowed for so many standard candles, according to the Gas Act in that particular locality. There was evidently a desire to meet what was in Mr. Hammond's mind, and what Mr. Preece also seemed to approve of, viz., to make the payment for electricity depend on the light supplied, as compared with that of gas.

The CHAIRMAN, in proposing a vote of thanks to Mr. Shoolbred, said the importance of the subject was proved by the great amount of skill already brought to bear upon it within very recent times. Several instruments, which were now exhibited, showed that there was more than one way in which the measurement of the current might be effected. and that either in the form of quantity or intensity, or of both combined. You might get indications of the amount of electrical energy passing at the time, which was important, and also, what was equally necessary, a record of what had passed in a given time; because it was of no service to the consumer to tell him, at this moment you are receiving a current of so many ampères of such a potential; he wanted to know how much he had to pay at the end of the year. With regard to Mr. Hammond's proposal that the unit might be one which would compare directly with 1,000 cubic feet of gas, he must say there were certain difficulties connected with it. First of all he should like to know what 1,000 feet of gas ought to do; the gas supplied in London did not do nearly enough; then, again, there was the question what burner was used. Electricity had one decided advantage—that you could only supply one quality; and it appeared to him that it would be to the benefit of the consumer not to take the dictum of Mr. Varley, or anyone else who said, "I can produce a 1,000-candle power with a current which, in the hands of another person, would only yield 500." No doubt the public would claim the advantage of all these improved lamps, and improved modes of utilising the current; but considering that the electric current of a given potential and representing so many ampères was a definite quantity which could not be tampered with or altered, he thought it would be best for the consumer to have

measurement. The meter, or recorder, should give at the end of the month or quarter the exact amount of electricity supplied expressed in watts, or any unit of a larger kind, which might be fixed. One of those units would be capable of producing as much light in an hour as so many cubic feet of gas of a given quality, and burned in a standard burner. It would not be difficult to establish a relation between the two things; but the measurement of electric energy, whether used for lighting or for the transmission of power, should be an absolute measure. Such discussions as this were very useful in fixing one's ideas with regard to these matters, and though they might not all be agreed on one definite mode of procedure, yet no doubt they would all go home to think over the subject, and the result would probably be a clearing away of the cloud which now hung over the whole question.

The votes of thanks to Mr. Shoolbred, and to the gentlemen who had lent instruments for exhibition, were passed unanimously, and the meeting adjourned.

Miscellaneous.

AMERICAN PATENT-LAW.

The following letter has been received by Sir Frederick Bramwell:—

Department of the Interior,
United States Patent Office,
Washington, D. C.,
March 19th, 1883.

My Dear Sir,—I have the honour to acknowledge the receipt of your favour of the 23rd ultimo, with copy of the *Journal of the Society of Arts*, containing the article read by you before the Society, Feb. 14th, and also copy published in 1874.

I have carefully perused your papers, and take pleasure in expressing my appreciation of the able manner in which you have discussed the subject of our patent system.

While our system is not a perfect one, its friends are making strenuous efforts to remedy its defects. As it stands, however, with all its imperfections, it has been of incalculable advantage in stimulating and advancing the growth and prosperity of every department of industry. The alliance of patents with the useful arts is so intimate, that whatever incentive and protection is given, the former must react in developing the latter.

I recall with great pleasure the interview you honoured me with in October last, and am gratified to have been of service to you bearing upon this subject, and should be pleased to give any further information in my power.

Thanking you for the interest and attention you have given our laws, and the practice connected with our patent system,

I am, very respectfully,
Your obedient Servant,
(Signed) E. W. Marble,
Commissioner of Patents.

Sir Frederick Bramwell, F.R.S.,

*THE MINERAL WEALTH OF BELGIUM.**

During the period of fifty-one years, from the end of 1830 to the 31st of December, 1881, 413,182,921 tons of coal have been raised from Belgian soil, representing a value of 5,054,000,000 fr. (£202,160,000). The output of 1881 was 16,873,951 tons, exceeding by 7,253 tons that of 1880. The extraction was effected by 76,322 hands underground, and 25,029 on the surface, making together 101,351, aided by 1,937 steam-engines, of 113,484 horse-power, for winding, pumping, ventilation, &c. The average annual wage of those employed both under and above ground, and including men, women, and children, was 931 fr. (£37 4s. 9½d.) in 1881, against 920 fr. (£36 16s.) in 1880. But, at the same time, the quantity of coal raised for each person employed has increased in a greater ratio.

The following quantities of the various ores were extracted during 1881:—Zinc ore, 23,553 tons; lead ore, 3,741 tons: iron pyrites, 2,965 tons; and iron ore, 224,882 tons; their extraction employing 2,750 hands. These ores are almost exclusively worked up in the country; but the imports, especially of iron ore, are considerable.

The working of the quarries is one of the most flourishing branches of the extractive industry of Belgium, as the country possesses numerous resources under this head. The following are the principal substances, with the quantities of each, obtained in 1881:—

Hewn stone.....	175,511 cubic metres.
Limestone	1,717,253 ,,
Paving stones	98,612,000 (number).
Flags	136,118 square metres.
Marble.....	8,422 cubic metres.
Slates	31,505,000 (number).
Tombstones.....	1,660 cubic metres.
Whetstones.....	120,000 (number).
Conglomerate	550 cubic metres.
Flux for blast furnaces	106,000 ,,
Plastic clay	171,779 tons.
Chalk	7,500 cubic metres.
Sand.....	369,665 ,,
Flint for earthenware..	15,250 ,,
Flints for building	227,600 ,,
Sulphate of baryta	12,400 tons.
Phosphate of lime	30,000 cubic metres.

The total value of these substances is 38,818,000 fr. (£1,552,720), as against 38,672,000 fr. (£1,546,880)

* Extracted from the Annual Report on Mining Operations, issued by the Minister of Public Works.

the previous year. The number of hands employed in the quarries in 1881 was 26,007. East and West Flanders and the Province of Antwerp only yield the tertiary clays, which serve for making bricks, paving and roofing tiles, as well as sand, of the same formation, used, among other purposes, in the glass manufacture. The yearly increase in the extraction of phosphate of lime in Hainault, is especially noticeable:—

Year.	Tons extracted.	Value.
1877	3,910	135,600 fr. (£5,424)
1878	5,720	208,900 fr. (£8,356)
1879	7,700	229,300 fr. (£9,172)
1880	15,745	567,000 fr. (£22,680)
1881	30,000	1,130,000 fr. (£45,200)

These phosphates are chiefly exported to England for the manufacture of artificial manure.

The number of steam-engines in the country—excluding locomotives and steam-vessels—is 14,742, and representing a power equal to that of 681,823 horses. They are provided with steam by 16,123 boilers, having a total heating surface of 750,000 square metres, or 185 acres.

During the year 1881, 258 accidents, causing the death of 315 persons, and severely injuring 82 others, occurred in the mines, open workings, quarries, and ironworks of the kingdom. This number is composed as follows:—

	Accidents.	Killed.	Wounded.
Collieries	237	296	77
Metalliferous mines (excepting iron)	3	2	1
Iron mines and open workings	4	2	2
Underground quarries	1	1	—
Works and factories	13	14	2
	258	315	82

The proportion of lives lost in collieries, including the hands on the surface, was 2·93 per cent. in 1881, 2·67 in 1879, and 3·15 in 1878; while for the period of ten years, from 1872 to 1881, the proportion is 2·48. There were, in 1881, four accidents to steam-boilers, occasioning the death of three persons, and severely burning a fourth.

During the same year the Corps des Mines published a map of Belgium, showing, graphically, the production, circulation, and consumption of ores, and the production of metals; and also a map showing the production per commune of the quarries of Belgium; both were prepared by M. A. Firket, *Ingénieur des mines*.

CASSIA LIGNEA IN CHINA.

Mr. Charles Ford, the superintendent of the Botanical and Afforestation Department, Hong Kong, has recently issued a report on a visit made by him to the Cassia districts of China, in which he proves that the Chinese Cassia Lignea of commerce is furnished by *Cinnamonum Cassia*, Blume. The tree was not met with anywhere in a wild state, nor could any native be found who knew where it did grow wild. There are three chief districts where the cassia is cultivated, viz., Taiwu, in lat. 23° 34′ N., and long. 110° 18′ E., in the Kwangsi province. Lukpo, in lat. 23° 6′ N., and long. 112° 24′ E.; and Loting, in lat. 22° 52′ N., and long. 111° 8′ E., both in the Kwangtung province. These are the market towns of the districts, but the cassia is cultivated over a large area of country, stretching to considerable distances from the towns, the extent of which could not be ascertained, owing to the untrustworthy accounts given by the different people questioned, who either had very vague notions of area, or were disinclined, as they usually are, to give information to foreigners. Taiwu is about four or five miles from the West River, and is reached by a pleasant walk leading over a plain; but the nearest cassia plantations are situated twenty-five or thirty miles further in a southern, or south-westerly direction, to which there is no communication by river. Taiwu is about 180 miles west of Canton. The Taiwu people said that the area of cultivation was not increasing.

The next most important, if not the most important district, is the Loting one, commencing at about eight or ten miles distant from the city of Loting. After leaving the West River, about eighty miles of the Loting River—the Nam-Kong—has to be traversed before reaching the city, and from thence the distance to the plantations has to be accomplished overland. One of the largest cultivators said that in this district there were about 1,000,000 mans (about 52,600 English acres) under cultivation, and that the area was greatly extending every year. The cultivation of cassia has been carried on here for only about twenty-five years, *i.e.*, since the Tai Ping rebellion, at which time, for the preservation of the plants and protection of them from destruction by the rebels, they were transferred from a district further south, at which it is reported the cultivation of cassia was abandoned when it was commenced at Loting.

The next district is that of Lukpo, which is much less important than the other two. The city of Lukpo is situated on the northern bank of the West River, and the plantations are situated at about fifteen miles between the nearest one and the city.

In addition to these places, there are several localities near the West River, at intermediate places, where small patches of cassia are grown, and, as the quantities of bark obtained are too small to send to market towns, it is brought off by small boats and sold to larger boats which carry produce down the river.

About six miles south-west of the small town of To Shing, which is situated on the southern bank of the river, about twenty-five miles above the confluence of the Loting and West Rivers, there are some plantations, from which, however, no bark has been obtained for two years, and no new plantations made for ten, because the low prices which can now be obtained for the bark do not leave any profit to the producers. This was the only instance which came to Mr. Ford's knowledge of the decrease of the trade in cassia production, although it is said that the Java cassia trade, in consequence of the lower prices at which the cassia can there be produced, is cutting out and crippling the China trade.

Appended to this report on cassia lignea are the following notes on vegetation of the West River. The West River proper is not reached until about twenty miles have been traversed from Canton by way of Fatshan, along one of the water ways of the great Delta. For this distance, and the next fifteen miles of the West River, *i.e.*, as far as the Shui Hing Pass, the land on both sides of the river is alluvial soil well cultivated. The first part has extensive tracts of rice fields surrounded with banks, on which are grown litchi, longan, and peach trees, with, at the base of the banks, the water cedar, *Glyptostrobus heterophyllus*. On approaching Fatshan, the mulberry tree is met with in fields, where it is grown for silk worm feeding. After passing Fatshan, the rice fields are replaced with mulberry trees and bamboos, the land being higher than the river and incapable of irrigation. On rising ground near the villages there are magnificent patches of arborescent vegetation, consisting of *Ficus retusa*, *F. Wightiana*, *Fraxinus chinensis*, *Bombax malabaricum*, and bamboos. The soy bean—*Scja hispida*—hemp, and the ground-nut—*Arachis hypogæa*—are cultivated on dry sandy soil. At forty miles from Canton the hills approach the river and form the Shui Hing Pass. A few miles to the east of this pass are the Ting U Shan woods, which contain some splendid trees, probably upwards of 150 feet high; amongst them were noticed *Bischoffia javanica*, *Cinnamomum parthenoxylon*, *Sterculia lanceolata*, and *Pinus sinensis*. These woods surround a fine monastery, and are protected by the priests. The frutescent vegetation here consists of well known plants that are common in South China. After passing the Shui Hing Pass, the hills again recede and leave a large plain on which, in addition to those plants mentioned as cultivated on the alluvial soil the other side of the pass, Indian corn—*Zea Mays*—is grown in summer, and wheat in winter and spring. *Euryale ferox* is also grown for the sake of its seeds, which are used as food by the natives. After leaving this plain, the hills approach the river, and leave only a narrow strip on each side for cultivation. On the steep hills are some patches of *Gardenia florida* cultivated for its capsules, which furnish a dye used for dyeing silk. Near to the Gardenia plantations are some of *Machilus velutina*, Champ, grown for the sake of its bark, which contains a glutinous substance used in the manufacture of joss sticks, as mentioned in the paper on cassia. *Camellia oleifera* is grown on barren hills in the vicinity of some villages to supply the growers with oil for cooking purposes, and for anointing their heads; it is not grown in sufficient quantities to sell.

A little above a town called Fung Chun, over one hundred miles from Canton, the narrow strip of land on the south bank of the river is planted with a forest of the Chan Ko Chuk bamboo, which is extensively used for boat poles and scaffolding. These plantations continued, with but slight interruptions, for about the next hundred miles.

On both sides of the river the country is very mountainous, the hills rising from 300 to 2,000 feet, and, with the exception of the level strips bordering the river, and a few patches on the hills of *Gardenia*, *Machilus*, tea plants, upland rice, and pumpkins, are entirely destitute of cultivation. There is very little grass on the hills, but ferns—*Gleichenia dichotoma*—abound, and cover the ground in every direction. The fern is cut and dried, and used extensively for fuel: even the limestone in the lime kilns, which are numerous, is burnt with this fuel only.

No forests are seen anywhere, but the Chinese are very careful to keep up, by annual sowing and planting, a stock of firewood, which, however, is confined to the common pine, *Pinus sinensis*, and the trees of this, instead of presenting the appearance of plantations well filled with handsome trees, are planted irregularly and thinly over the hills, and have, in most cases, but a miserable, stunted appearance, in consequence of the custom of continually cutting off the branches as they are required for fuel. Far up the river the *Cunninghamia sinensis* is found sparingly mixed with the pines, but this, also, never seems to attain a great size in the parts visited. *Cunninghamia*, however, it is said, exists in forests farther north; and this report seemed confirmed by the enormous rafts of China fir logs which were being floated down the river. The indigenous tree and shrub vegetation is continually destroyed as it attempts to grow, by the deplorable custom of the Chinese in cutting down every branch and sapling for firewood, the *Pinus sinensis* being the only tree which they attempt to renew by planting. Round the villages and temples the trees are protected, and these examples, especially the Ting U Shan woods, demonstrate the possibility of the Chinese mountainous districts producing splendid forests of a great variety of trees, if they were properly conserved. No proper system of forestry seems to exist anywhere, the only efforts in that direction being the promiscuous planting and cutting of pines for firewood, this being done in the same way as on the mainland and islands in the vicinity of Hongkong, any one being allowed to plant where he likes, and the Government exercising no control over the people in either planting or cutting down.

Fruit trees are only grown in small numbers dotted

about near the houses, except the jujube—*Zizyphus jujuba*—of which a great many orchards were seen; they were on the level ground near the river, and the trees were planted at distances of about 20 feet apart. In addition to these, one orchard of litchis on a hillside was seen.

Correspondence.

EGYPT.

In my paper read on February 27, I recommended the construction of a railway between Suakim, on the Red Sea, and Berber, on the Nile, as being the best route to open up the Soudan. From several remarks in the discussion which followed, and from the letter written by Lieut.-General Rundall, and published in your *Journal* on March 9, I fear that my reasons for this proposition have not been clearly put. If the Nile between Berber and Alexandria were navigable, that would obviously be the best route, but there are fifteen cataracts (or rapids) which would involve, even at high Nile, no less than ten transhipments of goods and corresponding lines of railway, one of which would have to be nearly 150 miles long. This sufficiently explains the impractability of utilising the Nile below Berber as a highway to the sea; and the impossibility of obtaining wood for fuel, together with the cost of tranrporting coal from Alexandria for use on these railways, is an additional reason against the feasibility of this route. I have, therefore, suggested the shortest and easiest route which can be found to connect the Red Sea with the unobstructed waterway to the heart of the Egyptian Soudan. There is no such difficulty as to fuel here, for although there is no wood to be found along this route, there would be no difficulty in obtaining coal at Suakim, or even transporting it, if necessary, for use on the Nile steamers.

I will not tresspass on your space by referring to other criticism which were made on my paper, but as the question of the best route to the Soudan is of vital importance, I must ask you to favour me by publishing this explanation. I am strongly of opinion that the short route of 250 miles from the Nile to the Red Sea which I have proposed would be far better than a costly, difficult, and tedious passage of 1,500 miles along the Nile from Berber to Alexandria.

ROBERT W. FELKIN, F.R.G.S.

Edinburgh, March 15, 1883.

NEW ZEALAND.

I was unable to be present at the last meeting of the Foreign and Colonial Section, but I have read with very much interest the excellent paper on New Zealand in the *Journal*. I think, however, that Mr. Hay's allusions to the Panama route, on page 461, require a few comments. It is quite true that there is a canal proposed across the Isthmus, but there has been, for many years past, a railway between Panama and Colon, and, of course, regular steam services between the latter port and England. I am not aware, however, of goods from New Zealand having been carried direct by that route, inasmuch as there is no steam service between that colony and Panama. There is a regular route from New Zealand by steamer to San Francisco, thence by rail to New York, and thence by steamer to Liverpool, by which mails, passengers, and even goods are conveyed, but owing to the heavy incidental expenses, and the United States Customs restrictions, it is but little availed of for the latter. For mails, however, this is a highly advantageous route, I having received letters by it from New Zealand in thirty-eight days, and, in point of speed, that route must, I imagine, always maintain the precedence far before a Panama route.

FRANK TAYLER, F.R.G.S.

10, Queen-street, Cheapside, London, E.C.,
2nd April, 1883.

Obituary.

F. W. CAMPIN.—On Sunday evening, 1st April, Mr. Frederick William Campin, Barrister-at-Law, and Secretary of the Inventors' Institute, died at his residence, Talfourd-lodge, Camberwell, aged 59. He contributed to the *Mining Journal* a series of letters on the Patent-laws, between 1845 and 1852, in which latter year the Patent-law Amendment Act was passed. He also gave evidence before the Committee of the House of Lords, and before the Committee of the House of Commons, when the Government Patent Bill of 1875 was under consideration. He was one of the original members of the Inventors' Institute, and has been its secretary since 1873. His work on the Law of Patents, in Weale's series, was published in 1878. Mr. Campin was an old member of the Society of Arts, which he joined as far back as 1846, and he was a frequent attendant at its meetings, especially those devoted to questions relating to the Patent-laws.

General Notes.

FRENCH ACADEMY COMPETITIONS.—The Paris Academy of Science will have to award at the public meeting of 1883, the three prizes of 10,000 francs (£400) each, founded by Dr. Louis Lacaze, for (1)

the work which has most contributed to the progress of Physiology; (2) to the best work on Physics; and (3) to the best work on Chemistry. Foreigners are admitted to compete, and works must be sent in before the 1st June, 1883.

VOLTA PRIZE.—The following are the conditions of the next competition for the Volta Prize of the Paris Academy of Science:—The prize of 50,000 frs. (£2,000), founded by the Decree of the 11th June, 1882, for the discovery or invention which shall render electricity economically applicable to one of the following applications:—Heat, light, chemical action, mechanical force, the transmission of messages, or the treatment of sick persons, will be awarded in December, 1887. The competition will remain open until the 30th June, 1887, and scientific men of all nations are admitted to compete.

SILVERING MIRRORS BY MEANS OF GLYCERINE.—Prof. Palmieri has devised a process for silvering glass by means of the reducing action on the salts of silver, which is said to have the advantage of producing a very brilliant metallic deposit. When into an ammoniacal solution of nitrate of silver is poured, first a little caustic potash, and then a few drops of glycerine, the reduction begins at once; and this action is accelerated if ether or alcohol be added to the mixture. A moderate heat and darkness are said to increase the brilliancy of the precipitate and darkness also favours the adhesion to the mirror of the deposit.

ELECTRICAL SAFETY APPLIANCE FOR THEATRES.—The model theatre of Brünn is illuminated by electricity, and also provided with an electrical safety apparatus, devised by Robert Langstouff Haviland, for use in the event of fire breaking out. By means of an electro-magnet, the incombustible curtain between the stage and auditorium is allowed to fall; the valves of water-pipes are opened, so as to discharge copious volumes of water on various parts of the building; extra doors are opened, and ventilators are closed. All these actions are effected by a key-board, put in the most convenient place, having five pushes labelled to correspond, while the sixth works all five at once, and may even be made to come into action automatically, by means of a very combustible wick or fusible metal attachment. The same system has been tried at Vienna.

ELECTRIC LIGHTING IN NEW YORK.—Mr. Arnold White, the secretary of the Edison Company, gives, in a letter to the *Times*, the following information as to the details of construction, cost, &c., of the Edison installation in New York. The Edison Company there have laid twenty-eight miles of mains, and 350 houses are wired for 6,400 lamps. At three o'clock on the 3rd of September last the station was started, and it has run day and night without a moment's intermission for any purpose. Meters have been placed in 341 houses, and the amounts due are collected month by month. The customers express themselves fully satisfied. The electric pressure throughout the system is maintained constant, and the daily tests show a variation of less than a single volt. These tests are made every night during the hour of greatest consumption, and the results are remarkable. The number of lamps burning on the system is at all times accurately and automatically shown at the central station.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

APRIL 11.—"The Portrush Railway and the Transmission of Power by Electricity." By ALEXANDER SIEMENS and EDWARD HOPKINSON, D.Sc. W. H. PREECE, F.R.S., will preside.

APRIL 18.—"The Government Patent Bill." By H. TRUEMAN WOOD, B.A. Secretary of the Society. RICHARD E. WEBSTER, Q.C., will preside.

APRIL 25.—"Economy of Sanitation." By CAPT. DOUGLAS GALTON, C.B., F.R.S.

MAY 2.—"The Relative Claims of Etching and Engraving to rank as Fine Arts." By F. SEYMOUR HADEN, F.R.C.S.

MAY 9.—"English and Foreign Silver Work; with Some Remarks on Hall-markings." By WILFRED CRIPPS, F.S.A. Sir PHILIP CUNLIFFE-OWEN, K.C.M.G., C.B., C.I.E., will preside.

THE DATES OF THE FOLLOWING PAPERS ARE NOT YET FIXED.

"Electricity as a Motive Power." By PROF. GEORGE FORBES.

"Technical Education in connection with Intermediate Schools." By PHILIP MAGNUS, B.Sc., B.A.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings at Eight o'clock:—

APRIL 12.—"The Formation of Diastase from Grain by Moulds." By R. W. ATKINSON, B.Sc. Prof. CHARLES GRAHAM will preside.

APRIL 26.—"A New Process for the Separation and Recovery of the Volatile Constituents of Coal." By T. B. LIGHTFOOT, M.Inst.C.E.

MAY 24.—"The Development of Electric Lighting." By J. E. H. GORDON, B.A.

INDIAN SECTION.

Friday evenings at Eight o'clock:—

APRIL 6.—"Historical Development of the Different Settlement Systems of British India." By W. G. PEDDER. Sir JAMES CAIRD, K.C.B., will preside.

APRIL 20.—"The Fisheries of India." By Surgeon-General FRANCIS DAY.

MAY 4.—"Some Notes on the Domestic Architecture of India." By C. PURDON CLARKE.

CANTOR LECTURES.

Monday evenings at Eight o'clock:—

Third Course, on "The Decorative Treatment of Metal in Architecture." By GEORGE H. BIRCH, A.R.I.B.A.

LECTURE II.—APRIL 9.

Bronze (continued).—Rome, Lombardy, Germany, Hildesheim, Italy, during the Middle Ages. The culminating point during the Renaissance.

Iron Work.—The Art of the Blacksmith, and the use of wrought iron in the north of Europe.

LECTURE III.—APRIL 16.

Iron Work (continued).—Germany—Augsburg and Nuremberg—15th and 16th centuries. England, 17th century.

Lead.—How used. Artistic treatment of the Middle Ages. Its capabilities.

Conclusion.—The use and abuse of metal work; modern bronze work; the decorative treatment of the metals, as applied in these days; our failures and successes.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. G. H. Birch, "The Decorative Treatment of Metal in Architecture." (Lecture II.)

Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Professor J. P. Sheldon, "Dairy Management."

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m.

British Architects, 9, Conduit-street, W., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, APRIL 10...Royal Institution, Albemarle-street, W., 3 p.m. Professor J. G. McKendrick, "Physiological Discovery." (Lecture II.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. P. O'Meara, "The Introduction of Irrigation in New Countries, as illustrated in North Eastern Colorado."

Photographic, 5a, Pall-mall East, S.W., 8 p.m.

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. Dr. J. O. Garson, "The Osteology of the Ancient Inhabitants of the Orkney Islands."

Royal Colonial, the Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Colonel George Bruce Malleson, "Haidarábád."

WEDNESDAY, APRIL 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Messrs. Alexander Siemens and Edward Hopkinson, D.Sc., "The Portrush Railway and the Transmission of Power by Electricity."

Geological, Burlington-house, W., 8 p.m. 1. Prof. Archibald Geikie, "The Supposed Pre-Cambrian Rocks of St. David's." (Part II.) 2. Mr. H. W. Monckton, "Notes on the Bagshot Sand."

Graphic, University College, W.C., 8 p.m.

Mechanical Engineers, 25, Great George-street, S.W., 3 p.m. Reading and Discussion of following papers:—1. Prof. A. G. Greenhill, "The Strength of Shafting when Exposed both to Torsion and End Thrust." 2. Mr. W. Ford Smith, "Modern Methods of Cutting Metals." 3. Mr. John Jameson, "Improvements in the Manufacture of Coke." 4. Mr. Alan C. Bagot, "The Application of Electricity to Coal Mines."

Microscopical, King's College, W.C., 8 p.m. 1. Mr. Malcolm Morris and Dr. G. C. Henderson, "The Life History of the Ringworm Fungus." 2. Mr. Chas. G. Matthews, "Notes on the Red Mould of Barley."

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

THURSDAY, APRIL 12...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Mr. R. W. Atkinson, "The Formation of Diastase from Grain by Moulds."

Mechanical Engineers, 25, Great George-street, S.W., 8 a.m. Reading and Discussion of Papers continued.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Society for the Encouragement of Fine Arts, 8 p.m. Conversazione at the Galleries of the Society of of British Artists, Suffolk-street, S.W.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. Waldstein, "Art of Pheidias." (Lecture I.)

Society of Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr. Shelford Bidwell, "Microphonic Contacts."

Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Prof. Wolstenholme, "Equations of the Loci of the Intersections of three Tangent Lines and of three Tangent Places to any Quadric $u = o$." 2. Lord Rayleigh, "Investigation of the Character of the Equilibrium of an Incompressible Heavy Fluid of Variable Density." 3. Mr. W. R. W. Roberts, "Motion of a Particle on the Surface of an Ellipsoid." 4. Prof. Forsyth, "Normal Integrals connected with Abel's Theorem." 5. Rev. M. M. U. Wilkinson, "Spherical Functions." (Part I.)

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. W. Bird, "The Sewerage of Berlin."

FRIDAY, APRIL 13...Royal United Service Institution, Whitehall-yard, 3 p.m. 1. Lieut.-General R. W. Lowry, "Coaling Ships or Squadrons on the Open Sea." 2. Paper by Lieut. R. S. Lowry.

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Dr. Waldstein, "The Influence of Athletic Games on Greek Art."

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, APRIL 14...Physical, Science Schools, South Kensington S.W., 3 p.m. 1. Mr. W. Lant Carpenter, "Some Uses of a New Projection Lantern—Science Demonstration in Board Schools." 2. Messrs. W. H. Stokes and A. E. Wilson, "Experiments on the Viscosity of Saponine."

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Geikie, "Geographical Evolution." (Lecture II.)

Journal of the Society of Arts.

No. 1,586. Vol. XXXII.

FRIDAY, APRIL 13, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Mr. GEORGE H. BIRCH delivered the second of his course of Cantor Lectures, on "The Decorative Treatment of Metal in Architecture," on Monday evening, 10th inst. He continued the history of bronze work to the culminating point of the art, during the Renaissance, and then passed on to consider the art of the blacksmith, and the use of the wrought iron in the North of Europe. Some specimens of wrought iron work were exhibited by Messrs. Phelps, Messrs. Hart, Son, Peard and Co., and Mr. Alfred Newman, and a brass fender, fire-irons, and screen by Messrs. Tonks. The exhibits of Messrs. Tonks and Son, and Messrs. Hart, Son, Peard and Co., will remain on view, with the objects exhibited by the Coalbrookdale Company, and Messrs. Perry and Co., mentioned in last week's *Journal*.

Proceedings of the Society.

INDIAN SECTION.

Friday, April 6th, 1883; Sir JAMES CAIRD, K.C.B., in the chair

The paper read was—

THE HISTORICAL DEVELOPMENT OF THE DIFFERENT SETTLEMENT SYSTEMS OF INDIA.

BY W. G. PEDDER.

The largest item among the receipts of the Government of India is the land revenue; and the most important fiscal and administrative operation of Government in India is what is technically called the settlement of the land revenue—that is to say, the decision of its amount, and who is to pay it.

Most people know that this decision is, in different parts of India, based on different principles; that in some provinces the settlement is zemindari, in others ryotwari; that the revenue is fixed in amount in some parts of the country, in others, is subject to periodical revision. But they have, I believe, but a vague notion of the reasons for these differences, and of these reasons it is my present object to give a general idea.

The original form of the land revenue was, without doubt, an actual share of the produce, paid by the cultivator or by the village community to the chief. The famous passage in the "Law of Manu," so often cited in justification of the State demand, lays down that the king is to receive the sixth, eighth, or tenth part of the grain, according—the commentator adds—to the quality of the soil, and the labour it needs. Upon this, two or three points must be noted:—

1. The "king" was the immediate chief, whether a great monarch, like the sovereign of Patan or Maghada, or the petty squire of a village, his feudal dependant. Before the Mahomedan conquest, the political system of India appears to have been quasi-feudal Subordinate to the different Hindu kingdoms—themselves numerous, and differing widely in extent—were the estates, larger or smaller, of nobles who owed service to the sovereign; and from them again were held smaller subsidiary estates of their kinsmen or dependants. The peninsula of Kathiáwár, never entirely subdued by the Mahomedans, presents in this, as in so many other respects, a kind of survival of ancient India. That small province now contains not less than 188 separate states, besides villages or lands held by way of appanage by the "Bhumias," the kinsmen of chiefs. Each chief or "Bhumia" receives, still generally in kind, the revenue of his domain, and exercises—or did until lately exercise—jurisdiction and some of the rights of sovereignty.

Now, in native parlance, and according to Hindu idea, the "king," the "rajah," to the peasant, was his immediate superior. Every noble in his own domain had most of the rights of sovereignty, while the paramount monarch, as far as his own estates were concerned, was like any other great proprietor. To the peasant it mattered little whether the king's share of his produce was received by

the petty chief of his village or by the sovereign of the country. Yet the distinction contained, as I shall endeavour to show, the germ of the important difference between the zemindari and the ryotwari systems.

2. The king's share, or "raj-bhag," was precisely neither a rent nor a tax, but was a due, and resembled other dues from the land. In England, the farmer pays the wright who mends his cart, the smith who shoes his horse, by the job, in money. It was not so, and to a great extent is not so, in India. The village artisans did all the work needed by the cultivators, and received in return, not money, which was little known, but a share of the grain at harvest. The superior village officers, the headman, accountant, priest, and the village watchman and scavenger were in like manner remunerated for their services by a share of grain at harvest. Just so the chief received his, but a much larger share, and in return for it gave—first, the use of the land of which he was lord—so far it was rent; secondly, his protection, and the administration of justice—so far it was a tax. It must, however, be noted that, as shown by the comment on Manu's text, the notion of the lord's share being chiefly a rent is a very early one.

Perhaps when the village community system was perfect, the whole produce of the village was thrown together, and divided in fixed shares between the cultivators, the village officers, and the lord. In Guzerat, alienated or private lands (such as temple lands) are still called "bahar-khali," *i.e.*, outside the threshing floor, because their produce was not brought into the common threshing place to be divided.

3. The proportion of grain actually received by the chief was probably never so low as that stated by Manu, who perhaps gave the law as he conceived it should be. The oldest information we have seems to show that the king's share was not ordinarily less than, and often exceeded, one-third.

Such, I believe, was the nature of the land revenue in the times prior to the Mahomedan conquest of India. It is accurately described in one of the earliest British enactments. Bengal Regulation XLI. of 1795 declares that "By the ancient law of the country, the ruling power is entitled to a certain proportion of the produce" (as much, Lord Cornwallis said, as the cultivator could afford to pay and still cultivate), "unless it transfers its right thereto" (which is an alienation of land revenue) "or limits the public demand upon the whole of the land belonging to an individual, leaving him to appropriate to his own use the difference between the value of such proportion and the sum payable to the public" (which difference is the property created by settlements such as those I am about to describe).

The second period in the history of the land revenue is that of Mussulman, especially Mogul, dominion, under which India undoubtedly flourished.

This period is marked by two great economic changes. To understand them, some brief preliminary explanation is necessary, especially as the subject is complicated by the very intricate Mahomedan land law by which the Mussulman rulers at least professed to be guided.

When the Mussulmans subdued a Hindu State, its territories became subject to the tax ("khiráj") on the lands of unbelievers. This "khiráj" was of two kinds, "mukásima," by which the produce was divided between the proprietor or cultivator and the State, and which was in effect the same as the existing Hindu due of the lord; and "muwazzaf" or "wazefa," which was a fixed cash assessment on an estate. The lands of which the subdued monarch was immediate lord became the crown lands, the "khás" or "khálsa," lands of the conqueror, and their cultivators naturally paid "khiráj mukásima" in kind directly to the State. But some of the Hindu chiefs, who had been subsidiary to the conquered monarchy, and owed it feudal service, still retained their estates as dependants, "taluqdars," of the new sovereign.

But it was not the policy of the Mahomedan kings to employ the military force of the Hindu chiefs; on the contrary, their object was to break the power and consequence of these nobles, and to wean them of the habit of taking the field at the head of their retainers. And they saw the disadvantage of their Government being the great dealer in produce, and the strength which it would derive from the command of a metallic revenue, needed for their public works, and for the standing army which their position as foreign conquerors required. (The Mussulmans, it is true, to a great extent paid their forces by "jaghires," or assignments of land revenue, but this was not the same as the old Hindu quasi-feudal system.) Hence the Mogul Emperors (and the same is substantially true of other Mahomedan rulers, the kings of Bengal, Guzerat, Ahmednagar, Bijapur, Berar, Golkonda) introduced the two changes referred to above.

1. They practically commuted the liability to feudal service of the surviving Hindu chiefs, by imposing on their estates the "khiráj muwazzaf." These nobles then continued to receive from their cultivators their old dues, and paid out of them a cash tribute, tax, or rent-charge. They were, in fact, in precisely the position of the modern zemindar. Of course, the great majority of existing zemindars cannot claim so ancient or so respectable an origin, but some undoubtedly can; for instance, the poligars of Madras, some, at least, of the nobles of Oudh, and the taluqdars of northern Bombay. The history of the tenure of the latter landowners affords so good an illustration of the process I am describing, that I will digress for an instant to sketch it.

Northern Guzerat, before its conquest by the Mahomedans, about A.D. 1300, formed part of the dominions of the Rajput dynasties who reigned at Anhilwara, and a large proportion of the province was held by numerous Hindu chiefs, feudally subordinate to those monarchs, who survived for a time the Mussulman conquest. When the celebrated Mahmûd Bêgara, Butler's

> "King of Cambay, whose daily food
> Is asp, and basilisk, and toad,"

consolidated and extended the Mahomedan kingdom of Ahmedabad, during the latter half of the fifteenth century, he treated these chiefs in one of two ways. In the tracts known as "rasté," peaceable or settled, that is, those in which his power was most firmly established, he commuted the feudal service by the confiscation of two-thirds of each estate. The portion so confiscated became "khálsa," or crown land, and its cultivators crown tenants. The remainder often still exists as the possession of the descendant or representative of the chief, exempt from land revenue, under the name of "wanta," or divided. But in the "mehwassi," or turbulent districts, their whole estates were left to the chiefs, a tribute in cash, nominally equal to two-thirds of the revenue of the estate, being imposed in lieu of service; and these are the existing taluqdari estates of Ahmedabad.

2. The second change was of still greater importance. It was the commutation in the "khálsa" territories of the "mukásima," or tax in kind on the land of the cultivators, into the "muwazzaf," or cash assessment, since called the "bigoti." The most extensive measure which effected this change is the famous settlement of Todar Mull, Akbar's Hindu minister, but there were other such settlements, of which, perhaps, the most important is that made in the Deccan, early in the 16th century, by Malik Ambar, the Abyssinian minister of the Nizám Sháhi kings. And, though they have long been superseded, they are still vaguely referred to by the peasantry under such names as the "mámul bigoti," or established assessment, the "asal dar," or original rate, the "rakhba," or settlement, the "nirakh," or legal charge.

Todar Mull's settlement is thus described by Dr. Hunter and other authorities. He first executed a survey to measure the land; he then found out the produce of each biga of land, in which he was aided by the records of the former dues in kind; he fixed the Government share at one-third the gross produce; he determined the value of this share on the average prices of nineteen years; and this sum he fixed as the cash assessment for a period of ten years, on the expiration of which it was liable to revision on similar principles. Where the village constitution was on the joint system, the community were made jointly responsible for the total revenue assessed on the village.

Two interesting questions may now be noticed with reference to Akbar's settlement.

1. What was the incidence of his assessment as compared with that of present assessments?

Much light has been thrown on this question by the researches of Mr. E. Thomas. It appears that in A.D. 1580, the land revenue (exclusive of taxes and cesses) from the thirteen provinces north of about latitude 20°, was about 1,320 lacs of rupees. The existing land revenue in the same provinces is now about 1,400 lacs. The purchasing power of silver, expressed in the prices of the staple food grains, has fallen three-fifths, while the assessed and cultivated area of the provinces is now much larger than in 1580. Dr. Hunter therefore concludes that Akbar's assessment was three times as heavy as the present assessments. This agrees with the general estimate that modern assessments do not, on average, exceed one-tenth the value of the gross produce. The estimate made by the Famine Commission (p. 112 of Part II. of their report) of the incidence of modern assessments is a good deal lower than one-tenth. It must also be remarked that the land revenue rose immensely, partly from extension of territory, partly also, I presume, from increase of cultivation, rise of prices, and heavier exactions, in the century after Akbar's death. In 1697, it is stated

to have been 3,795 lacs, from twenty-two provinces, which include some territory now native states, but are exclusive of the greater part of Madras. The total land revenue of British India is now 2,190 lacs.

2. Was Akbar's assessment a tax or a rent? It was called, as I have shown, a tax. It was undoubtedly not an economic rent, for it was fixed by the State, not dependent on the existence of different qualities in the soil and different returns to the capital employed, and not determined by competition, and it was paid by persons cultivating not for profit but for subsistence. But still it was, I think, a real rent, in the sense of being something paid for the use of land. Every person who took up for cultivation a field, did so on the express agreement that he should pay for it a fixed annual sum, just as the cultivators who have taken up the seventeen millions acres of Government waste land, which have been brought under the plough since 1850 in Madras and Bombay, have each made a similar agreement, expressed in his lease ("pottah" or "khátá"). This point is practically important, because, as will be seen, the existing rents of Upper India are derived from the "bigoti."

It must be observed that while Mahomedan settlements on the above principles, or something resembling them, appear to have been carried out in the greater part of the "khalsa" territories of Eastern, Upper, and Western India, they did not extend to the South, which did not come under Mussulman rule till a late period. The old Madras revenue system was a very complicated one, and varied much in different districts. But I believe it is generally correct to say that, while the ancient Hindu principle of the right of the ruler to an actual share of the produce (generally a very large one, one-half or even more) was nominally maintained, the cultivators were required to pay in cash the value of that share, at rates annually fixed with reference to the prices of produce. This especially applies to the dry lands. The assessment on rice lands was generally, or often, levied in kind. (See Sir T. Munro's Minute, dated 31st December, 1824.)

The third period in revenue history was that of anarchy, from the death of Aurungzeb till the beginning of the present century, during which the Mahratta power was predominant. It was marked, first, by excessive and tyrannical exaction of land revenue, every power which rose to the surface endeavouring to extort the utmost from the landholders and cultivators. Secondly, by the great extension of the farming, or, in the technical sense of the word, zemindari system.

That system was briefly this. Some person, sometimes an ancient chief or a local magnate, sometimes a banker, often a Court favourite, sometimes an hereditary revenue officer, sometimes the headman or headmen of a village, agreed with the ruler who happened to be in power to pay a lump sum for the land revenue of a tract of country, a district, a pargana, or a village. Usually, the bargain was founded on a stipulation that the amounts levied from the ryots should be the ancient, usual, or customary assessments, which should be paid over with the deduction of a per-centage for collection. But, in fact, this stipulation was generally merely nominal, and was not meant to be observed. The Government took as much as a farmer could be got to offer; the farmer exacted that amount from the ryots, and as much more profit for himself as he could in any way manage to extort, even by torture and other oppressive measures. But often the ryots succeeded in maintaining some reference to their old or established rates of asssessment, the increased demand being levied by extra cesses ("abwabs" or "veeras"), or by separate rates on the land. For instance, when the invading Mahrattas levied "chouth," or a fourth of the revenue of a conquered province, the means to comply with this demand was often provided by an extra rate on the land. The term for which a farm was granted was generally short, but the farmer often succeeded, by Court or local influence, or from being able to offer more than a new man, in getting his farm successively renewed. Finally, the farmer frequently sublet portions of his farm, and, in particular, would often call on the hereditary district officers to contract, at an exorbitant sum each, for his own circle of villages. These men, again, with the object of making a profit out of the transaction, farmed single villages, sometimes to a person not connected with the village, but more commonly, especially when the village system was strong, the headmen, to avoid the interposition of a stranger, or under compulsion, agreed to pay for their village sums far exceeding what any reasonable assessment would produce. They also tried to make some profit at the expense of the other cultivators, who thus had to pay, not only the heavy demands of the Government, but also the profits of a variety of middle-men.

Such was the general state of the land revenue when it came into the possession of the East India Company. And it is not surprising that the earliest British rulers, finding in existence a class of men who practically fixed in detail the demand on the land for their own profit, paying out of it a lump sum to Government, concluded that they were landlords in the European sense, which indeed some of them, either ancient nobles whose estates had survived Mussulman conquest, or grantees of estates by subsequent Governments, really were.

This belief led to the zemindari permanent settlement of Bengal, and to the similar settlements in the province of Benares, and in parts of Madras. It is not, however, of course essential to the principle of a zemindari settlement that the amount of revenue should be fixed in perpetuity; the assessments were made permanent for political and economical reasons, which were at that time thought conclusive. It was considered that permanency of assessment would bind the land-owners to the Government which had granted, and which alone would maintain, so great a boon; that it would encourage the investment of capital in land, and, therefore, the growth of a middle-class; that it would lead to more lenient and considerate treatment of the tenants by the landlords, and would thus promote general prosperity, and consequently an increase of commercial and general, as well as of agricultural wealth; and hence, that the sacrifice of a prospective increase of land revenue would be made up by increased ability of the population to contribute to general taxation, especially to the indirect taxation which, in the days before free trade, was thought to afford the most legitimate and least injurious mode of filling the Treasury. Without entering into controversial matters, I may say that it is now the more general opinion among Indian administrators that these anticipations have been only very partially realised, as regards the provinces which were brought under a permanent zemindari settlement three generations ago.

The application of the principles on which these settlements were made to other British acquisitions in Madras, Bombay, and Upper India, was contemplated at the beginning of this century. And it is not generally known how near this policy was to being carried out. In the "Attavesi," or twenty-eight parganas of the Surat province, for instance, which came under British rule in A.D. 1803, the revenue was then farmed by certain hereditary officers called "dessais." The position and functions of these dessais, under the Mogul rule, are perfectly clear, having been defined by a firman of the Emperor Aurungzeb. Their duties were to assess, to collect, and to pay over to the treasury the revenue due by the cultivators; their remuneration, besides some fees and free lands, was 3 per cent. on their collections. Originally there was one dessai to each pargana, but as time went on, the dessai families, according to Hindu custom, divided their rights according to the rule of inheritance, alloting single villages, or even shares of villages, to individuals; that is, each member of the family assuming the management and the emoluments of a division of the original pargana, corresponding to his hereditary interest in the office. When Mahratta rule succeeded to that of the Moguls, and the farming system was introduced, their local influence enabled the dessais to obtain the farms of their districts. Each dessai then began to treat his village, or share, as his absolute property, demanding what rent he chose from the cultivators. The latter, however, struggled to maintain their old rights, and on one occasion brought the dessais to terms by abandoning the district in a body; and the rates levied by the dessais on the introduction of British rule were commonly called "bumni bigoti," the double rate, or double the legitimate rate; which shows the feeling of the peasantry that the demand of the dessais for discretionary rent was a usurpation. In 1803, therefore, the position of these dessais, or, as they preferred to be called, zemindars, was precisely the same as that of the zemindars of Bengal, and a similar settlement with them was contemplated. But the first collector, Mr. Morison, I believe an old Bengal officer, pointed out that the real landholders were the ryots. Mr. Jonathan Duncan, the Governor, who had been Resident at Benares, and was intimately acquainted with the settlement question, acceded to this view. When, therefore, the farming system was got rid of, the earliest annual settlements were made with the ryots, and, from that time, the "khalsa" lands of Bombay have been dealt with on this principle.

Very nearly the same thing took place in Madras. There, the adoption of the Bengal system of settlement was ordered by the Court of Directors, in 1795, not only as regards the estates of the great chiefs and of the poligars, which are still under it, but also as regards

the "haveli," or crown lands. As applied to them, however, it failed generally, and after some time was entirely abandoned, chiefly under the influence of Sir T. Munro.

Early in this century, then, it was decided that the principles on which the settlement of Bengal had been effected were erroneous, or not everywhere applicable; and, finally, after various experiments, the different kinds of periodical settlements now in operation were determined on.

By each of these settlements is decided—1st, who is to pay the land revenue; 2nd, its amount. But the principles on which these decisions are based vary, chiefly from local and historical differences, partly also from differences in the views and policy of the authorities who laid them down, and I will now endeavour to give a very general sketch of current settlements as respects these two points.

1st. In some provinces, the peasant cultivators, who everywhere in India till the land *en petite culture*, hold immediately from, and pay their revenue or rent directly to, the State. In others, they hold from, either with or without some occupancy right, and pay rent to, private persons who may be shortly, though not altogether accurately, called their landlords. Elsewhere, they are either members or tenants of a village community which jointly holds from and pays to the State. Infinite are the varieties of these tenures and of the rights of the cultivators and of the superior holders. But on the three great differences sketched above are based the three great varieties of settlement,—the ryotwari, the commonest in Madras and Bombay; the zemindari, taluqdari, or malguzari, that of Oudh and of the Central Provinces, as well as of Bengal; the village system, prevalent in the North-West Provinces and Punjab.

Speaking generally, the systems of settlement correspond in a general way to differences of land tenure which were found in existence by the British. In the greater part of Madras and Bombay (though by no means everywhere in those Presidencies) the early British authorities found that their territories were what I have called "crown" or "khalsa" lands; that there existed no class with any permanent or hereditary right which intervened between the right of the cultivators to till the land, and that of the State to receive the revenue; that the village communities were not bound together by joint or mutual responsibility for the revenue; and that every peasant was answerable only for the fields he himself cultivated. A ryotwari settlement, that is, one made for individual fields and with individual holders, naturally followed upon such a state of things. Elsewhere two distinct classes were found in possession of distinct interests and responsibilities in the land—the tenants as payers of something which was given for the use of the land, and so at least resembled rent; the landlords or superior holders as recipients of that rent and payers of revenue. Such landlords were the zemindars of Bengal, on the vexed question of whose original or acquired rights and position I need not further touch in this paper. Such also were the taluqdars of Oudh, some of whom are apparently ancient hereditary nobles, some persons who acquired or usurped the position of landlords during the Mahomedan sovereignty of that province. There exists, or existed, a similar class in some other parts of Upper India, and the question whether the settlement should be made with the taluqdar, and he should thus be acknowledged as proprietor, or whether he should be treated as the mere holder of a rent-charge, or "malikana," on the estate, was one of the most controverted points in the original settlement of the North-West Provinces. But whenever, as generally in Oudh, and, in some exceptional cases, in the North-West Provinces, the taluqdar was recognised as proprietor, the settlement was made with him upon his estate as a whole, or at least on the villages comprised in it, not on the individual fields; and his tenants were either left to defend their customary rights, if any, against him in the courts, or were protected by legislation or a sub-settlement.

The history of the settlement of the Central Provinces is somewhat different, since there the proprietary right of the malguzar, or landlord, was, speaking generally, the intentional creation of the British Government. While the cultivators had no rights in the soil beyond the vaguest and most ineffective right of occupancy, there was no existing class of landlords. It was deemed expedient, for economical reasons then thought sufficient, to create a class of landlords, and an individual was selected to receive the proprietary right in each village, sometimes the hereditary headman, sometimes a stranger who had for some time farmed its revenue, and the settlement was made with him and upon the village.

There remains the third, or village system of settlement.

Sir G. Campbell in "Modern India," has

pointed out that there is in India a twofold form of the village community, the simple, or "aristocratic," and the joint, or "democratic."

The distinction is perhaps to some extent an ethnological one. The aboriginal races have little of the principle of association so strongly marked among the Aryans of India, and accordingly, so far as I have observed, the joint community, or its traces, is found chiefly among the purer Hindus, and in the provinces most completely settled by the Aryans.

Under the simple form, the community consisted of a mere aggregate of cultivators, under a single headman, probably appointed by the Rajah. Under the joint form, the village was originally founded by a family, or association of families, of the cultivating castes, who, with their servants and slaves, fixed the village site, dug the well and tank, planted the grove, built the wall and temple, and thus exercised proprietary rights. In process of time, the descendants of the original founders divided among themselves, in accordance with the Hindu rule of inheritance, either the profits of the land which they owned in common, or, now more usually, the land itself. The community induced artisans to settle in their village, who were their servants, and were remunerated by shares of the produce. The village was governed, not by a single headman, but by a committee of representatives of the community, who, among other duties, managed the payment of his revenue to the ruler. And in time other cultivators were attracted to the village, whom the proprietary body allowed to cultivate, as their tenants, such lands as they did not want themselves. Hence arose the distinction, pointed out by the Court of Directors, in 1825, as existing in most parts of India, between proprietary cultivators ("khudkasts," "mirásdárs," "patadárs," as they are called in different provinces) and non-proprietary cultivators ("paikasts," "oopris," "gatkuls," "parakadis").

In Western and Southern India the joint system generally broke down, where it ever existed, during the times of anarchy, and the distinction between proprietary and non-proprietary cultivators commonly disappeared when the latter acquired, under the ryotwari settlements, the proprietary right which no one was left to contest with them. As the Mahrattas say, "the Government has made us all mirásdárs." But this was not the case in Upper India, partly because the joint village constitution was there originally stronger, partly because it had been maintained or acknowledged by Akbar's settlements, partly because, during the prevalence of the farming system, the headmen had commonly farmed the revenues of their own villages. Hence the British Government found in existence two well defined classes of cultivators, the village proprietary bodies and their tenants. The acknowledgment of the proprietary right of the former, and a settlement made upon the village with them, through their representatives, the "lambardars," naturally followed. And the minor distinctions of settlement, the zemindári (in the North-West Provinces technical sense), the perfect and imperfect patidári, and the bhyachára, turn on the modes of distribution of the village lands and profits among the proprietary body.

It will then be observed that, with insignificant exceptions, there is no longer such a person as a tenant of the State. In the ryotwari provinces, the Government tenant has been converted into a peasant proprietor. Elsewhere, the cultivator, if not himself a proprietor, is a tenant of the zemindar or of a proprietary body.

2nd. Both in the North-West Provinces, in Bombay, and in Madras, the principle adopted for the determination of the amount of land revenue in the earliest regular settlements was that of a per-centage on net produce. It was attempted to ascertain for each field, or at least each class of land, the average gross produce and its value, and to eliminate therefrom the net produce (*i.e.*, the amount remaining after deducting cost of cultivation and profits of stock), a proportion of which was to be the Government assessment. This principle proved an entire failure in the North-West Provinces, and was formally abandoned by Regulation IX. of 1833. Upon it was based Mr. Pringle's abortive settlement of the Bombay Deccan, about 1830, which utterly broke down. It has never been applied in the settlement of territories such as the Punjab, Oudh, the Central Provinces, which came under British rule after 1840. And the only province in which it is still, at least nominally, maintained is Madras.

Under the Madras system, the average yield of certain staple crops per acre of each class of land is ascertained by a great number of actual experiments, extending over a series of years. The average gross produce thus determined is converted into cash at the "commutation rate," or average harvest price

of the twenty or more years' preceding settlement. The average cost of cultivation and profits of stock are then ascertained by careful and extensive investigation, and the amount arrived at being deducted from the value of the gross produce, the balance is net produce. Half the net produce is the "revenue rate" per acre, or Government cash assessment, and the quantity of grain representing this sum at the "commutation rate" adopted is the "grain assessment."

Such is the theory of the Madras settlement. In practice, however, it has been found impossible or dangerous to adhere to it strictly. In the first place, the difficulty of determining with accuracy the average yield of land is great; next, the only way of finding the average cost of cultivation is to ascertain what it would cost to cultivate a given holding by hired labour, and, as this labour would be needed for only a certain number of weeks or months, it is obvious that nothing would be allowed as wage for the subsistence of the cultivator and his family during the rest of the year. Hence, the first step in a Madras settlement practically is to determine, on general considerations (such as those which I shall immediately describe under Bombay), whether the tract coming under settlement requires a decrease, or will bear an enhancement, of its land revenue, and to what extent. The total amount of assessment to be imposed having thus been decided on, the results of the process above described are adjusted so as to yield it. The estimates of average yield are reduced to allow for error or for exceptionally bad seasons, and the commutation rate is lowered, to cover possible fluctuations of prices in the future. In practice, therefore, the elaborate process I have described determines rather the relative than the absolute assessments of different classes of land, and the Madras method does not really differ very widely from that of the Bombay settlement.

The Bombay method is avowedly an empirical one. When a tract (usually the subdivision of a district) comes under settlement, original or revised, its revenue history for the preceding thirty or more years is carefully ascertained and tabulated in figured statements and diagrams. These show in juxtaposition, for each year of the series, the amount and incidence of the assessment, the remissions or arrears, the ease or difficulty with which the revenue was realised, the rainfall and nature of the season, the harvest prices, the extension or decrease of cultivation, and how these particulars are influenced by each other; the effect of any public improvements, such as roads, railways, canals, markets, on the tract or on parts of it is estimated; the prices for which land sold, or the rents for which it is let, are ascertained; and the tract is compared as regards the above particulars, with other tracts similar to it in soil, climate, and situation. Upon a consideration of all these data; the total settlement assessment is determined. That amount is then apportioned, pretty much in the same manner, upon the different villages. And the total assessment of each village is then distributed over its assessable fields in accordance with their classification, which determines their relative values in point of soil, water supply, and situation.

One point with reference to the classification deserves particular notice. The founders of the Bombay settlement system, Sir G. Wingate and Mr. Goldsmid, were deeply impressed with the truth of the theory of rent, as expounded by Ricardo and his school, and were fully convinced that Indian assessments could be safely based only on it. Not that they believed it possible to ascertain what is the exact amount, in cash or in produce, of the economic rent of a field in Bombay; but they thought that the relative valuation of fields should vary in the same proportion as their rents, if determined by economic conditions, would vary. And in particular they held that as the least fertile and worst situated land in cultivation can pay no economic rent, such land should bear no assessment, or but a nominal one. Hence the Bombay scale of assessment has a very wide range. While the best irrigated land is assessed as high as Rs. 15 an acre, or even higher, the poorest and worst situated dry lands are assessed at one anna, or even half an anna (three farthings), and a holding often comprises some land not assessed at all.

It will have been seen that the rent for which land actually lets is one of the minor elements taken into consideration in deciding on the amount of Bombay assessment. To base the assessments chiefly on existing rents would be impossible where, as in Western and Southern India, the proportion of land let is almost infinitesimal in comparison with that of land cultivated by its owner. But this is not the case in Upper India, where, as I have shown, a large though varying proportion of land is let out to tenants, and where there exist distinct classes of rent payers and rent receivers.

When, about 1832, the Government of India determined finally to abandon the attempt to ascertain the net produce of land for the settlement of the North-West Provinces, they decided to substitute, as the basis of the assessment of each estate its actual "assets," that is to say, where the land is let out for cultivation, the rents actually paid by the tenants (unless obviously inadequate in particular cases, when a "fair rent" founded chiefly on the prevailing rates of rent is substituted for the purpose of the calculation); where the land is cultivated by its proprietor, its fair rental value, assumed on a consideration of the prevailing rent-rate of similar lands let in the vicinity and of other circumstances. The former method of calculating the assets is naturally that chiefly relied on in Oudh, where there are large landlords; the latter among the village communities of the North-West Provinces. These methods are considerably modified in the Punjab and Central Provinces settlements, and where rents are chiefly paid in kind, and sometimes approximate to the Bombay plan. But, speaking generally, whatever the exact method employed, the principle of settlements throughout Upper India is to ascertain the rental value of each estate, and to fix a proportion of that value as its assessment. In the original North-West Provinces settlements (made *circa* 1833—44 for thirty years) this proportion was two-thirds; on revision it was reduced to one-half; and the latter proportion is now universally adopted in the settlements of Upper India, though to it must be added the local cesses, some 10 per cent. of the assets.

There remains, however, a very interesting and important question. What are the rents paid by tenants in Upper India; how did they originate, and on what principles are they determined?

Sir Auckland Colvin has shown, in the very interesting papers which he wrote in 1872 on North-West Provinces settlements, that the rents which the tenants of the North-West Provinces were paying on the introduction of the original settlements were simply the existing revenue rates, fixed under official control, "rates of the public revenue, not of the individual rental." He believes that the origin of particular rates, how they came to be fixed, and why they vary, cannot now be traced. But it may be generally said that, with great modifications caused by local custom or circumstance, by State action, or by individual caprice, the rents in kind were derived from the old Hindu due of the lord, the rents in cash from the Mahomedan "bigoti."

It may well be asked, how did revenue rates fixed and received by the State consist with any proprietary right of the persons through whom they were paid; were not the tenants who paid them tenants of the Government, not of the zemindar or of the proprietary community? The answer, one almost unintelligible to English ideas, is that during the period of anarchy the proprietary interest in land was not necessarily or even usually a beneficiary interest; the proprietors sometimes had to pay Government more than they received from their tenants, *i.e.*, the rates on their "seer" or domain land were higher than on the lands they let; yet the latter lands reverted to them, not to Government, if thrown up, and they were responsible for them.

In the Broach district, for example, where the village system and the rights of the proprietary communities were very strong, the assessment, under the old revenue system, was one-third of the produce, yearly converted into cash at current prices. The proprietary body levied this sum, whether on the lands they themselves cultivated, or on those let to tenants, and paid out of it the cash revenue assessed on the whole village, which ought to have left them a margin of profit for expense of collection. But Sindia and his farmers over-assessed the district so severely, that the village assessments exceeded the detailed field assessments by upwards of a lac of rupees. This difference the proprietary bodies had to make up, except so far as they could realise it by extra cesses on their tenants, out of the produce of their own lands, in proportion to the hereditary share of each member in the villages. I believe that innumerable similar instances might be cited from most provinces.

These rates then, less the usual per-centage for collection and anything which the proprietor or farmer could manage to withhold, formed the authorised Government revenue in 1830. And what the original settlements of the North-West Provinces did was to reduce the Government gross demand by one-third, and to leave that portion of the proceeds of the rates (besides any increase during the thirty years' term of settlement) to the persons or bodies decided to be proprietors.

Now Mr. Bird desired that, at the time of settlement, Government should fix for its term, not only its own revenue, but the rent rates to be levied by the proprietors. This proposal

was, however, rejected by the Government of Lord William Bentinck in 1832, and the future amount of rents was left to be settled by bargain between the landlords and tenants (an entirely new principle, it will be observed) save so far as it is limited by law in the case of tenants declared to have occupancy rights. The existing rent law in most parts of Upper India is based on the principles of Bengal Act X. of 1859, which are very briefly these. A few tenants, ex-proprietors, or those whose holdings are of ancient date, hold at fixed or favourable rent rates. All tenants who have held the same land continuously for twelve years have occupancy right in respect of that land, and its rent can be enhanced only in proportion to an increase in the value of its produce. And the mass of tenants hold simply from year to year, at the will of their landlords, and at rents the amount of which is decided by bargain with the landlords. Under the Punjab law, however, lapse of time alone does not give occupancy right, and in Oudh, the principles of Act X. have not been applied, and there about 98 per cent. of all tenants are tenants from year to year.

Hence it occurs that, on the revision of a settlement in Upper India, the settlement officer has a very different task from that of the officer who made the original settlement. Speaking generally, the latter had only to ascertain what were the existing revenue rates, the revenue they yielded, and the proportion of that revenue to be fixed as the settlement assessment of the estate. The former has to ascertain the amount of the existing private rental of the estate, as modified during a generation by the new principle of bargain, and by the action of the law. These influences have acted very irregularly on rents in the North-West Provinces. While on some estates, where the landlords are vigorous and grasping, rents have been enhanced since the original settlement 40 or more per cent., in others, where the landlord was inert or the tenantry resolute, rents have hardly risen at all.

The above will, I think, show how closely the question of settlement and the question of tenant right are connected. And it must be observed that the amount of revenue and the amount of rent react on each other. On the "half-assets" principle, the landlord who has enhanced his rents should pay, on a revision of his settlement, half the enhanced amount as revenue. Nor is it of any use to leave his revenue at the original amount if he has not enhanced his rental, for there is nothing to prevent his raising his rents the day after the new settlement is completed, and thus to get the better both of Government and of his tenants. On the other hand, if his revenue is enhanced, he can provide for the new demand only by raising his rents. There can be no doubt that in Oudh, the heavy assessments mistakenly imposed by the settlements first made after the annexation of the province led to an enormous and oppressive enhancement of rents. The assessments have since been revised and greatly lowered, but the enhanced rents have not fallen again in proportion, and, as we know from Mr. Irwin's interesting book, "The Garden of India," and other sources, complaints of rack-renting in Oudh are now common.

It is, of course, quite impossible for me to give, in this paper, any complete statistics of the varieties of settlement and land tenure which I have just tried to sketch, but perhaps I may usefully give some idea of the comparative extent to which they prevail in the different provinces.

In Madras, rather more than one-third of the total area of the presidency is held by zemindars or landlords under permanent settlement. There are also holders of temple lands, and other lands exempt from revenue, who are practically landlords; and there are, in some places, tenures—such as the Jenmi tenure in Malabar—which are rather zemindari than ryotwari. The rest of the presidency, or more than half its entire area, is held ryotwari by peasant or cultivating proprietors. The average area of a peasant holding is seven acres, and its revenue assessment averages Rs.1 13a. 1p. per acre.

In Bombay, there are, in three districts, some 300 villages held by proprietary cultivating communities. In three districts a large proportion of the land is held by zemindars, the taluqdars whom I have before described. One district is largely held by a class of village zemindars, the "khots." All through the presidency, a good deal of land is held by inamdars, jaghirdars, and similar proprietors, who are practically landlords, and let their lands. These tenures together amount to something like one-fourth the area of the presidency; the remaining three-fourths are held ryotwar by peasant proprietors. Their holdings average 19 acres, and their rate of assessment about Rs.0 15a. 8p. per acre.

In the Punjab, 5 per cent. of the total area is held by large zemindars, and 91 per cent.

by cultivating village communities, the remaining 4 per cent. by small proprietors and others. The rate of assessment is about Rs.0 13a. 3p. per acre. Of the lands owned by the village communities, 62 per cent. is cultivated by the proprietors themselves, 13 per cent. by tenants with occupancy rights, and 25 per cent. by tenants-at-will.

In the North-West Provinces, 3 per cent. of the total area is owned by large zemindars, 90 per cent. by village communities, 7 per cent. by others. The rate of assessment is about Rs.1 2a. 3p. per cultivated acre.

In Oudh, 59 per cent. of the total area is owned by large zemindars, 36 per cent. by village communities, and 5 per cent. by small proprietors; 98 per cent. of the tenants are tenants-at-will, or, more accurately, tenants from year to year. The rate of assessment is about Rs.1 10a. 6p. per cultivated acre.

In the Central Provinces, practically the whole area is owned by zemindars. Of the tenants 37 per cent. have occupancy rights, and the remainder are tenants at-will. The average rate of assessment per cultivated acre is about Rs.0 6a. 9p.

In Bengal, there are no statistics, but the land is chiefly owned by zemindars.

In this paper I have been obliged to omit all reference to the minor varieties of settlement, such as those of Burma, Assam, and Sind, which differ in some respects from any of those of which I have endeavoured to give a sketch, necessarily brief and much generalised. If any one wishes to study the subject more in detail, I will refer him to two excellent works lately published by the Government of India, Mr. Baden Powell's "Manual of the Land Revenue System," and Mr. Stack's "Report on Current Settlements."

DISCUSSION.

Sir W. R. Robinson, K.C.S.I., said it was difficult to make casual remarks on a paper so logically drawn up as this was; however widely he differed from Mr. Pedder as to its tone as a whole, he did so with hesitation, because that gentleman had taken a very broad view of the matter, while he could only touch on what had come under his own observation, viz., the land system of Madras. He entirely differed with Mr. Pedder as to the conditions of Hindu proprietary rights in land. Allusion was made in the early part of the paper to a feudal system, and possibly, in a political point of view, something analogous to it had long existed; but as an agrarian question, he considered the view given of the Hindu conditions was very defective, and probably misleading. The law of Manu was an expression of the Hindu idea of landed property, and that idea included simply the ruler and his moderate claim against the crop and the ryot, the proprietor; anything which came between—be he collector, assignee, feudatory, or the like—was simply an accident; the basis of the whole was the recognised proprietary position of the ryot, and admitted claim of the ruler. The paper seemed to view the whole question from the zemindar point of view, which he believed was an erroneous and unhistorical one. Viewed from a historical and Hindu stand-point, there was no such thing really as a cultivating zemindar, and a tenant holding under him. In using such expressions as "tenants," "holding from," and the like, one was using alien, non-Asiatic terms, for which there was absolutely no equivalent in the accurate agrarian diction of India. No Indian ryot ever held from any government or zemindar, and "crown" lands did not exist, speaking from the essential stand-point of Hindu law or Asiatic conditions. No ryot was ever required to go to the ruler, or to those who Mr. Pedder said occupied to the ryot the place of the rajah, the political chief of the district or of the village, for leave to use his own land in his own way, or paid a "rent" for so doing, as implied by Mr. Pedder; at least it was not so in Madras, and he did not believe it was so anywhere. In basing practically the whole paper on the idea of rent, he believed he had failed to grasp the true Hindu notion with respect to land, and to do justice to the rights of the true proprietary body of India. He would ask him if he knew any Hindu word which conveyed the idea of "rent" in the English sense of the term. The Hindu law provided that the ruling power should have a moderate and legally defined and fixed claim on the proprietary of the country, the ryots; and as long as that was one-eighth or one-tenth of the crop, it left a valuable estate behind it, and that estate belonged, by indefeasible and prescriptive title, to the owner—the ryot. The ryotwari settlement of Southern India was based on purely Hindu principles, to which the idea of "rent," "tenure," limited "tenant right" and the like are absolutely alien. Under the Asiatic condition, the landed proprietary were generally collected in villages, but each man occupied a piece of land, of which however, he was the owner, not the tenant. There sprang up, naturally, a class of men who may be called, as Mr. Pedder terms them, nobles — but they include headmen of villages, temple dignitaries, and intermediaries of almost Protean shapes—and, in one way or another, they got into their hands the collection of the revenue demand from the ryots; but that did not interfere with the proprietary right of the land, nor were they justified in asking more from the ryot than the State legally claimed. Of course, the power of collection soon led to great abuses, and thus the zemindari system sprang up, which, to India's great misfortune, the British rule, with its

feudal prejudices, has stereotyped on many parts of the country. The new Madras settlement was absolutely a Hindu settlement as between the State and the proprietary; they had not to settle who was to pay the rent, because the Hindu law had settled that; the valuation of the crop, described by Mr. Pedder, was not to settle the rent, because there was no rent to be paid; it adjusted the ruler's claim against the landed proprietary, and no more. In this respect the paper scarcely adequately set out the principles of a true Indian or ryotwari settlement. The paper said the Government tenant had been converted into a peasant proprietor, but that was not so. He had been a peasant proprietor from time immemorial. There had been a ratification of the old legal Hindu and prescriptive titles of the ryots, which had been religiously respected by all strong Hindu Governments in South India in their settlements, and by no people more honestly than by the Mohammedans wherever they succeeded to the ruling power. In Kanara, the ancient Hindu settlement of the Bedanur Government of the 15th century was a pure ryotwari settlement of a permanent and fixed character. At the time there were a number of zemindars and poligars scattered over the country, but the State went right through them, and settled with the proprietary of the country, and the result was that the intermediaries in great measure disappeared. The Mohammedans accepted and affirmed absolutely the Hindu settlement, and though they added new shamilats or enhancements, they were not so numerous or heavy as those imposed by the Hindu Government between the time of the fixed settlement of 1400, and the time of the Mohammedan succession. In Malabar they did the same. They ascertained from the native ruling princes and jenmis, or poligars, what they had been receiving from the ancient proprietary, or kanomdars and patomdars, and accepted that as the basis of their future settlement of their conquest. Thus the Mohammedan rulers recognised and ratified the main features of the Hindu law and agrarian conditions of society in their settlements with the true proprietary body of landholders. Would that we—especially as respects Malabar—had done so as fairly. Mr. Pedder had very concisely traced the way in which the Madras settlement had been effected, very much in the same way as the Hindu valuations were made, by dealing with every field separately, and with each proprietor individually. As to the unearned increment, whatever that might mean, it is now going into the right pockets, viz., to the proprietor of the estate; while as concerns the State, the settlement had been fairly and moderately made, and it only remained that it should be made permanent. He could quite conceive that many of the school which was now very strong in India, would take exception to the settlement being made permanent, in accordance with Hindu and even Mohammedan precedent—where undisturbed by zemindari influences and alien analogies. When Sir Thomas Munro pleaded the people's (ryotwari) cause, it was not against making a fixed and certain demand, but against departure from sound agrarian disposition and imperilment of existing private property in land, as distributed amongst the ryots. He for one was perfectly prepared to wait, for he felt that the time was coming when no Government would be so injudicious as to do anything which should shake the value of every acre of land in India. Few in England had any idea of what was meant by settlement, and its effect on the value of land and condition of the people; or the enormous disturbance which occurs when the value of every investment in land was shaken, generally for the worse by resettlements, and no one knows what is coming next. Nor did he believe the people would long stand it. Some permanence of property was an immense boon to any country, and the people were already protesting in a very decided way against the excruciating rents which were being raised, and he was glad to see they were being met in a very righteous and generous way by the present Governor-General. He had no doubt that feeling would grow, and that the day would come when the new settlements in Madras would be made permanent, and the new rates would become the new reka-shist, or fixed and immutable rent-charge or revenue demand, on the principle which had obtained under all true and well-ordered native settlements. He was not speaking of the cruel, disorderly, and illegal state of things which had sprung up all over India when others came in between weak States and the proprietary, in times of anarchy, as has been well described, whether under the Hindu dynasties, Mahrattas, Mohammedans, or under the British. Happily, in Madras, even where lands were held under permanent settlement, these middlemen were to some extent inhibited from raising their so-called rents.

Mr. PEDDER said the Madras High Court had decided that there was no limitation on the right of the zemindar to raise the rent of the ryot.

Sir W. ROBINSON asked when that was decided, as he had not heard of it?

Mr. PEDDER said it was about four years ago.

Sir WILLIAM ROBINSON said that was since he left India. He was surprised to hear it, and should think it only applied to some particular zemindaris, such as the western zemindaris of North Arcot. It was a great misfortune, and it springs from misconceptions of ryotwari property, and false analogies fostered by the use of the alien term "rent" in practice and legislation. In the closing part of the paper, there was an allusion to what is called "Zenmi tenures" in Malabar, a condition which is justly described as more zemindari than ryotwari. The story of these usurpations is possibly the saddest in India, and least creditable to our administration, a contrast in this respect with even Tippu's rule; but it was too long and complex for the present discussion. Suffice

it to say that the noblest and most independent of the ryotwari proprietary—the kanomdars and patomdars—of the country are being crushed out by exactions at the hands of oppressive dethroned princes, temple dignitaries, and other men of family (jenmi), who have constituted themselves, with the aid of the judiciary, and in traverse of the ancient law of the land, zemindars of worse than Bengal type, and that unrestrained on the ostensible ground of their being tenantry-at-will.

Mr. MATTHEW said it was hardly necessary to dispute whether there was such a thing as rent in India, which Sir William Robinson denied; there certainly was a payment contingent on possession, which came to the same thing. He must protest against the views expressed by Sir William Robinson on one point, viz., that there should be a fixed payment upon all lands. They knew that in India great improvements had been made by irrigation (which he hoped would be extended), which had added greatly to the value of lands affected, entirely at the expense of the State, and it was absurd to contend that the holders of these lands were not to pay a higher assessment in return for these improvements effected by the imperial power. As a well-wisher to India, he must protest against such an idea.

Mr. E. KIMBER said, it was his duty, as solicitor to the Commons Protection League, to examine every tenure in this country from its foundation, and having followed Mr. Pedder's paper very closely, he could find an analogy to every kind of holding which had been mentioned in the history of this country. The free ryot whom Sir William Robinson held up to their admiration was in the same position as the ancient socman of England; the freeman, or common holder of property. Again those who had to bow at the feet of the rajah, were in a similar position to the tenants of a manor. The lord of a manor in this country was similar to the rajah. In India they were more backward in some respects than England, but in other respects they were more forward. Sir William Robinson said there was no such thing as rent, but if the cess was not paid, the Government could come and seize everything. Now, in this country, neither under a *fifa*, nor an *elegit*, the strongest writ known to the law, could a man's land be seized; you could only enter into possession, and take the rents and profits until your debt was extinguished. He sympathised as much with the ryots of England and Ireland as with the poor freeholders of India. He felt much indebted to Mr. Pedder for the paper, and he did not understand that it was an advocacy of the zemindari system at all; it was a fair and impartial statement of the whole case. But he was looking for some indication of the way in which men's minds ought to be directed with regard to the proceedings of the Government in India. The people of India were not able to express their opinions with the same freedom that we could in this country, but he hoped that by means of this Society and others their views might find full expression. He should have liked to have Mr. Pedder's opinion with regard to recent legislation in India; on the one hand they were told that it was a confiscation of the rights of the zemindars, and, on the other, that it was a restoration to the ryots of their ancient freeholds. These things were called by furious names on each side, and what was really wanted was a fair statement of the case, in order that the public might be in a position to give a fair and candid opinion on the question.

Mr. COTTON said he had been employed for sixteen years in Bengal in the revenue department, but was not prepared to speak from personal knowledge of the other provinces. He knew nothing about the ancient Hindu settlement, nor did he believe any one else did. The Mohammedan system certainly did not recognise proprietary rights in any one except the State. The East India Company found a state of things existing, in which the occupiers paid a rent or tax to the Government, and in order to save trouble and expense in collecting it, it was made permanent. When the amount was fixed and certain, the people found means to pay it, and the accounts could always be kept. It was stated that the revenue payable under Akbar was much larger than at present, and that might be so, but he did not believe the amount collected was so great. He had always observed that the nominal assessment was much higher than was ever collected, and it was probably so in old times. He had no doubt the fixed amount was the highest which could ever be got in favourable seasons, and that the average was far below it. At the present day a native zemindar showed an enormous rent roll, but in an ordinary year he never collected anything like the amount. The settlements were now conducted almost entirely with a view to a future increase of revenue, being based on the fertility of the land, irrigation, markets, &c., But there were other things still more important than the fertility of the soil, which were entirely neglected, viz., the historical antecedents of the village and of the individuals who were liable. Nothing was more oppressive and unjust than the hard and fast system of settlement which existed. As secretary for three years to the Board of Revenue in Bengal, he always found the enhanced settlements most unpopular. In some cases rents were nearly doubled, and the districts were greatly disturbed in consequence, not that the land would not bear the rent, but because due regard was not had to historical antecedents. The old settler and the high caste man always paid less under the Hindu system than the new settler, or the low caste man, but they were all made to pay the same. Again, you might find a whole village of palki-bearers, who, under the former zemindar, paid nominal rents in consideration of bearing his palanquin free; if that estate came under the Court of Awards, a re-settlement was made, and the rent was raised, because the

services were not rendered; forgetting that in a few years the estate might come back to the old proprietor, who would reimpose the service, and at the same time claim enhanced rents. It was stated by Mr. Pedder that non-occupancy ryots formed the large majority of tenants in Bengal; but this he believed was an error.

Mr. PEDDER said he believed the statement referred to was made in reference to Oude.

Mr. COTTON said there was no new legislation in Bengal; a Bill had been introduced and published in the papers, but it would not be passed for another year at least. With regard to occupancy rights, there was not such a great difference introduced by the new Bill as was at first contemplated. Occupancy rights were acquired very largely under the old law. Sir William Robinson said there was no such thing as Crown lands; he did not know exactly what Crown lands were in England, but he presumed that they were lands which paid a revenue rent or tax direct to the officers of the Government, and there were many such estates in Bengal, and in most of them the rents were settled with the ryots direct. In Bengal they went further in direct management than in any other presidency. There were local collectors who had an office in the village, and collected direct from the ryots, without the intervention of any middlemen at all. It was an arduous experiment, and had not succeeded very well.

Mr. MARTIN WOOD thought Mr. Pedder had treated the subject in a very able manner, and that it would be well if professors of political economy would take this paper and make it the subject of discussion in their classes, when dealing with the land question. Mr. Kimber had pointed out that the old English land system was very similar in many points to the Hindu; but after all, what was best administered was best. He agreed with Mr. Pedder in thinking the Bombay system the best; but even the best system would not work well in the face of obstacles which were too strong for it. *Apropos* of the opinion of people in India on the matter, he held in his hand a paper which he thought would exactly meet Mr. Kimber's requirements. It was a criticism by Mr. Hunter and the Supreme Legislative Council on the Bombay Revenue system. The following was a quotation from the *Hindu Patriot*:—"Dr. Pollen, the Special Judge entrusted with the administration of the law, states that the ordinary Deccan ryot does not gain enough from the produce of his fields to pay the Government assessment and to support himself and his family throughout the year." No doubt the assessment was intended to leave enough, but somehow it did not; in fact, the whole economic condition of the country required looking into. Sir William Wedderburn had shown that the principles laid down by the first Secretary of State, in 1856, as those on which the enhancement of revenue should be conducted, had not been exceeded; and the important question remained—How was it there was not sufficient prosperity to enable the cultivator to pay these moderate assessments?

The CHAIRMAN (Sir James Caird, K.C.B.), in proposing a vote of thanks to Mr. Pedder for his extremely able paper, said it came very opportunely at a time when the questions of India were coming to the front, and it was of the greatest importance that the people of England should have a clear knowledge of the systems of land tenure in India. The point to which he would refer as rendering the paper most interesting, was the fact that the settlement of Lord Cornwallis, nearly 100 years ago, in Bengal, was now becoming a question for discussion in India. The Bill of Mr. Ilbert, which after some discussion had been postponed, was one of the greatest importance. It would appear that when the English first entered India, with every desire on the part of the Government to do that which they thought right with regard to the land tenure, misled by what seemed like the relation of landlord and tenant in this country, they mistook the collectors of revenue for the real landlords of the country, and they proceeded to fix, at a permanent figure, the amount of land revenue to be taken by the rulers of the country, in order to leave to the cultivators the greatest encouragement to develop the land for their own benefit. But in doing so, they recognised only one in eighty of the people who really were interested as landholders, and expected that that one-eightieth would exercise towards the other seventy-nine the same feelings of justice and consideration. That, however, was not realised, and it was of great importance that this question should be thoroughly understood in this country as well as in India. The paper now read would furnish excellent data on which they might discover what were the rights of cultivators, as well as of those zemindars who were the collectors of the revenue for the State. He had been much struck with the principle laid down by Manu, the great Hindu lawgiver, many centuries ago, as to the share of the produce to be taken by the State, which was very nearly akin to the amount of rent in this country. That principle was that, according to the quality of the land, and the labour it required, the rent or revenue paid should vary from one-sixth to one-eighth or one-tenth of the produce. Now, taking into account the quality of the soil, cost of cultivation, and opportunities for market, rent in this country would be, for the best quality, one-fourth or one-fifth; for the second quality, one-sixth to one-seventh; and for the worst, something like one-eighth of the produce; or very nearly the proportion stated in the law of Manu. It did not appear to him that any one of Manu's successors had so clear an idea of what was the just principle on which rent should be assessed. As a Famine Commissioner, he thought it absolutely necessary for

the protection of India from that terrible scourge of famine which must surely be looked for from time to time, that railway communication should be increased. For thirty years Government had been trying to do this, but the entire extent, after all that time, was not equal to what was accomplished in the United States in a single year. Illinois alone, a State having a population about 1-100th that of India, possessed as many miles of railway as the whole of India. These railways were made by European money—to a great extent by English money—raised by debenture stock; and he could not see why, with the present abundance of capital seeking investment, railways in India should not be much further developed, on the principle of a moderate guarantee. An attempt had been recently made to construct railways in India without a guarantee, but not with great success. When he came home four years ago from India, he strongly recommended the advantage which would arise to agriculture in India, and the great protection it would be in case of famine, if there were a more rapid increase of railways. And after inquiry in the City, he suggested that if a guarantee were given by the Government to the extent of three per cent., with the whole profits above that left to the people who undertook the construction of the railway, the capital might easily be raised. He did not think the Government of India could make a better investment, and there seldom had been a more favourable time for it.

The vote of thanks having been carried,

Mr. PEDDER thanked the meeting for the compliment, and said he agreed much more nearly with Sir William Robinson than he seemed to suppose.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 11th, 1883; WILLIAM HENRY PREECE, F.R.S., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Ough, Henry, 16, Austin-friars, E.C.
Porter, Captain Henry Richard, R.A., 32, Belgrave-road, S.W.
Roebuck, Rev. Alfred, Rookfield-avenue, Sale, near Manchester.
Selous, Edric, M.D., 133, Adelaide-road, South Hampstead, N.W.
Tate, A. Norman, 9, Hackins Hey, Liverpool.

The following candidates were balloted for and duly elected members of the Society:—

Anderson, James, 19, Strand, Calcutta.
Bartlett, Herbert H., Tredegar Works, Bow, E.
Bostock, Henry, The Oaklands, Rowley-avenue, Stafford.
Dawson, Philip William, 96, King Henry's-road, N.W.
Hammond, Frederic, 2, Mercers-road, Holloway-road, N., and 2, Coleman-street-buildings, E.C.
Lever, Charles, Culcheth-hall, Bowdon, Cheshire.
Marshall, George Stansfeld, 41, Elsham-road, Kensington, W.
Mason, James, J.P., Eynsham-hall, Witney, Oxon.
Silverlock, Henry Thomas, 32, Elgin-crescent, Kensington-park, W., and 92, Blackfriars-road, S.E.
Stuart, John Medley, 20, Addison-road North, Kensington, W.

The paper read was—

I. THE TRANSMISSION OF POWER BY ELECTRICITY.

II. THE PORTRUSH ELECTRICAL RAILWAY.

BY ALEXANDER SIEMENS AND EDWARD HOPKINSON, D.Sc.

I. Nearly two years ago I addressed the Society on the subject of "Electric Railways and the Transmission of Power by Electricity." I now venture again to bring the subject before you, in conjunction with Mr. E. Hopkinson, in order to show the advance which has been made in the interval in actual applications, and to develop the theory of the subject more completely than was then possible. At the time of reading my former paper, there existed only one electrical railway, viz., the Lichterfelde line, near Berlin, and even this had but a short time previously been opened for traffic. Since then Messrs. Siemens and Halske have constructed, in addition to their pioneer undertaking at Lichterfelde, a line, 1½ miles long, from Charlottenburg to the Spandauer Bock, and a short line, worked only in the summer, in Rostverloren-park, near Amsterdam. They have also applied the system to a railway in the mines at Zankerode, in Saxony. At the International Electrical Exhibition in Paris, under the direction of Dr. Siemens, an electrical line was worked by Messrs. Siemens Fréres, between the Palais de l'Industrie and the Place de la Concorde, which carried an average of over 13,000 passengers per week; and more recently, in the North of Ireland, the towns of Portrush and Bushmills have been connected by an electrical railway, six miles long, which will presently be described in detail.

It is unnecessary to refer further to the Lichterfelde line, as the details of its con-

struction were given in my previous paper; suffice it to say, that for over two years it has worked continuously without hitch or accident of any kind.

The engine employed in the mines at Zankerode is shown in side view and in section on the diagram on the wall. The dynamo is placed with its axis lengthwise on the car, and works one pair of driving-wheels by means of bevel gear. The current is conveyed along the roof of the workings by means of an inverted T-iron rail, on which a contact carriage freely slides, and connects with the engine by a flexible cable carried down the tube. The return current is taken by a similar cable and carriage to a second conductor, fixed by the side of the first. It is obvious that for mines the simpler method of using the rails themselves for conductors could not be advantageously employed, as they are in general very roughly laid, and frequently shifted, which would make it difficult to maintain proper electrical conductivity. The engine is reversible, and the handles making and breaking the current, and the brake levers, are worked from either end, so that the driver always faces in the direction in which the engine is moving. The gauge of the line is 18 inches, the diameter of the wheels 13 inches, the extreme dimensions of the engine, length between buffers 8 feet, width 2 feet 7 inches, and, its weight 1½ tons. It can develop sufficient power to draw a load of 8 tons, at the rate of 7½ miles per hour. Without going further into details, these figures will be sufficient to show how powerful an engine it is for its bulk and weight, and its adaptability for the special purpose for which it was constructed.

Leaving for the present the subject of railways, I will now show two examples of electrical transmission of power, as illustrations of the diversity of its possible applications, and then describe the electrical lift, and use it to illustrate the general theory of the subject. First, there is here an ordinary centrifugal pump drawing water from the tank below, forcing it through the tube, and returning it again to the tank. The pump is worked by a strap from the Siemens machine, used as a motor, and the current is obtained from a somewhat larger machine, which is ordinarily used for lighting this room, but which, for the present, has been taken for the purpose of the experiment. Such a pump, coupled direct to its dynamo machine and mounted on wheels, would make an excellent fire-engine, as it is very easily handled, and can be started at a moment's notice by sending a current through it. At some future time, when electric mains run along our streets by the side of the water mains, there will be no difficulty in obtaining the necessary currents from "electricity" plugs placed alongside the fire hydrants. At present it would be necessary to transport secondary batteries with the electrical fire-engine, but even with this drawback the great advantage would be obtained of having the full power of the pump immediately ready for use, and every minute gained is of importance. A further advantage lies in the possibility of connecting the water main direct to the pump, as the pressure of the main would thus be utilised, and no water wasted. Now let the pump be disconnected, and replaced by the very small motor working the sewing-machine. It is important to observe that the same generator is used in both cases, and that neither its speed, nor any other of its conditions have been altered, excepting only the pull on the driving strap; but that, in the case of the pump, probably about 5-horse power of useful work was being done, while in the case of the sewing-machine perhaps one-fiftieth of a horse-power. Now, without stopping the sewing-machine, the whole of the 40 Edison incandescent lamps required for lighting this room shall be connected with the generator. The sewing-machine still performs its one-fiftieth of a horse-power of work, while from the same generator and the same leading wires, about 5-horse power are employed in lighting the room.

These illustrations will be sufficient to show, in the first place, that when once we have electrical mains of sufficient capacity carried from central stations to our houses, how simple a matter it will be to combine lighting with domestic operations, and even the larger operations required for purposes of trade; and, in the second place, that each motor of a series placed in parallel circuit, performs the work required of it independently of all the others, and independently of the generating machine, provided only that the generator is capable of producing the power it is called upon to furnish.

This second point I will now show to you in a different form, and explain it mathematically. The diagram represents an electrical hoist, designed by Dr. John Hopkinson, and made by Messrs. Siemens Bros. The electrical part consists of an ordinary D_5 series dynamo, fitted with reversing gear

for reversing the direction of the current and the lead of the brushes, and, consequently, the direction of rotation of the machine. In the mean position, both pairs of brushes are lifted from the commutator, allowing no current to pass. The dynamo runs at a high velocity, and consequently is connected by spur gear to the lifting axle, to diminish the speed of lift and increase the leverage. On this axle a chain pulley is fitted by means of a special friction clutch, which need not now be explained. The clutch automatically holds the weight attached to the chain, as soon as the dynamo is stopped. Having coupled up the leads to the terminals of the machine, and hung a weight of one hundredweight on the chain, start the dynamo, measure roughly the speed of lift, and by means of the electro-dynamometer the current passing through the dynamo—

Weight.	Speed.	Current.
1 cwt.	5 feet per sec.	9 ampères.

Now let the attached weight be doubled without altering any other conditions, and again measure the speed and current—

Weight.	Speed.	Current.
2 cwt.	3 feet per sec.	12½ ampères.

You will observe, as you would expect, that with the heavier weight, the speed has diminished and the current increased.

Secondly, I will again put on the weight I had in the first experiment, but insert a resistance of 2½ ohms in the leading wire. Again measuring the current and the speed, we have—

Weight.	Speed.	Current,
1 cwt.	2·5 feet per sec.	9 ampères.

You will see that the current is exactly the same as before, while the speed has diminished. Taking again the double weight, and leaving the resistance inserted, we have—

Weight.	Speed.	Current.
2 cwt.	1 foot per sec.	12½ ampères.

Again the same current as we had before with the double weight, but a diminished speed. From these experiments, it is clear that for a given load the current remains constant, whatever the speed may be, and that the speed principally depends upon the resistance through which the current passes.

On the diagram is shown the results of a series of experiments with the same hoist, made at the works of Messrs. Siemens Bros., under conditions which allowed of greater accuracy than is possible here to-night.

Resistance inserted in circuit, in ohms.	Work done. Load 56 lbs. 7·3 ampères.		Work done. Load 1 cwt. 9·2 ampères.		Work done. Load 2 cwt. 12·9 ampères.	
	Speed in feet, per minute.	Foot lbs., per minute.	Speed in feet, per minute.	Foot lbs., per minute.	Speed in feet, per minute.	Foot lbs., per minute.
·3	212	11,870	180	20,160	130	29,120
1·2	190	10,640	164	18,370	112·5	25,200
2·2	169	9,480	150	16,800	90	20,160
3·2	157	8,790	130	14,560	71	15,900
3·7	150	8,400	125	14,000	59·5	13,330
4·8	141	7,850	111	12,430	36·5	8,180
5·7	130	7,280	90	10,080	19	4,260
6·3	129	7,200	84	9,410	—	—
8·3	98	5,480	56	6,270	—	—
9·7	80	4,230	27·3	3,060	—	—
11·6	47	2,628	—	—	—	—
12·7	35	1,960	—	—	—	—
14	18	1,008	—	—	—	—

Three conclusions are to be drawn, which are the fundamental principles of the theory of the electrical transmission of power.

I. The motor, as a machine, is entirely independent of the generator, and must be designed for the particular work it has to do without reference to the generator.

II. The current depends upon the load on the motor, and upon no other thing whatever.

III. The speed depends upon the E.M.F. of the generator, and the total resistance in the circuit of the machines. If the mains which supply the current to the motor be maintained at a constant potential, and

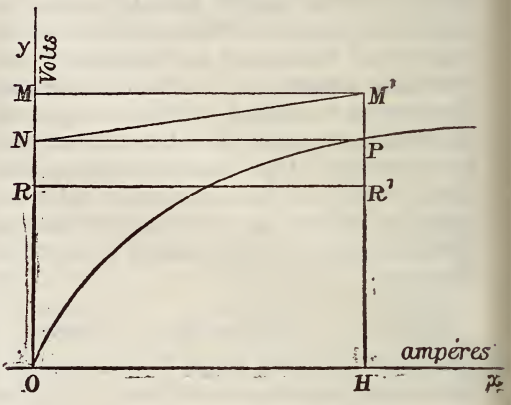
the motor be separately excited, or have permanent magnets, the speed is proportional to the potential of the main, less the loss of potential due to the resistance of the armature.

As a practical corollary, the generator must be designed to give the current required of it by the motor, and E.M.F. sufficient after allowing for fall of potential through the resistance of the mains, to give the requisite speed. Keeping these points in view, it is easy to design a combination of machines for performing any particular work, and to calculate exactly the efficiency of the combination, and to account for the various losses that occur.

Now let us put these considerations in a mathematical form. The first problem is:—Given a main with a constant E.M.F. denoted by E, to construct a dynamo machine, drawing its current from the main, to work with a given load L, and at a given number of revolutions n per minute. Let us make use of the characteristic curves, used by Dr. J. Hopkinson, Dr. Frölich, M. Marcel Deprez, and others.

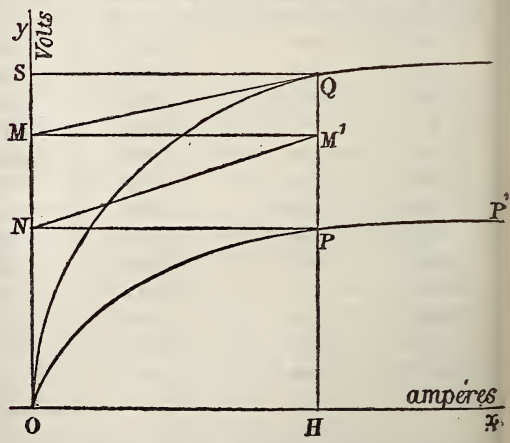
Take Ox, Oy as axes of co-ordinates, along Oy cut off O M, representing the E.M.F. of the main in volts. Now, the makers of each type of dynamo machine know appoximately the percentage of energy their machines absorb in producing the necessary magnetic field. Take a point N in O M, such that the ratio $\frac{O N}{O M}$ is equal to this percentage. Again, it is known that a dynamo is not an absolutely perfect machine, but that a certain amount of energy is wasted in the friction of the bearings, and of the brushes against the commutator, and also in induced currents in the core of the armature. Take O R, such that $\frac{O R}{O N}$ represents the efficiency of the machine. This, in the case of the Siemens machine, is at least 90 per cent. From Ox cut off O H, such that the rectangle O H R′R represents the power required from the motor expressed in watts. Then O H is the current passing through the motor, measured in ampères, and H P is the inverse E.M.F. The proper motor, therefore, is that dynamo which, when running at the given number of revolutions n per minute, has a characteristic curve passing through the point P. The total efficiency is evidently the ratio of the rectangle O H R′R to the rectangles O H M′M, which is equal to $\frac{H R'}{H M'}$; the electrical efficiency is $\frac{H P}{H M'} = \frac{E'}{E}$, the ratio of the inverse E.M.F. of the motor to the E.M.F. of the main. The energy spent in magnetisation is measured by P N M M′, and the tangent of the angle P N M′ represents the resistance of the armature and magnets.

FIG. 1.



The second problem is:—Given a motor requiring a certain current and E.M.F. for the work it has to do, to construct a suitable generator, the distance between the machines being represented by an electrical resistance R measured in ohms. Let O P P′ (Fig. 2) be the characteristic curve of the motor, when running at the required speed; O N the E.M.F. in volts, and O H the current in ampères. Let R′ be the sum of the resistances of the motor and conductor. Draw P N perpendicular to Oy, and make the angle P N M′ having its tangent equal to R′; then M′ H repre-

FIG. 2.



sents the difference of potential between the terminals of the generator. Produce H M′ to Q, so that $\frac{Q M'}{Q H}$ is the ratio of the energy expended in producing the magnetic field to the total energy of the machine; then the generator is that dynamo which, when running at its proper speed, has a characteristic curve passing through the point Q.

The electrical efficiency of the combination is the ratio $\frac{P H}{Q H}$, *i.e.*, the ratio of the E.M.F. of the motor to the E.M.F. of the generator, which, if the machines are similar, is equal to the ratio of their speeds. The energy converted into heat in the wires of the machine, and in the conductor, is N P Q S; and the total efficiency of the combination is the ratio of the electromotive forces, multiplied by the product of the efficiencies of the two machines, considered separately. The conductor connecting the two machines has been considered to be perfectly insulated. Of course this is not practically attained, but I will not now consider the point particularly, as it has very recently been discussed from an analytical point of view, by Dr. O. J. Lodge.

The diagrams might be used for proving many other points of interest in connection with the theory of transmission of power, especially Jacobi's law of maximum effect; but I think it will probably be of more advantage to leave the rest of the time at our disposal to Dr. Edward Hopkinson, to describe the Portrush Railway, the electrical part of the work of which he has had in charge, under the direction of Dr. Siemens, particularly as it will illustrate how these principles have been carried out in practice, and the results obtained therefrom.

II.—The Portrush Railway.

In the summer of 1881, Mr. W. A. Traill, late of H.M. Geological Survey, suggested to Dr. Siemens that the line between Portrush and Bushmills, for which Parliamentary powers had been obtained, would be suitable in many respects for electrical working, especially as there was abundant water-power available in the neighbourhood. Dr. Siemens at once joined in the undertaking, which has been carried out under his direction. The line extends from Portrush, the terminus of the Belfast and Northern Counties Railway, to Bushmills in the Bush valley, a distance of six miles. For about half-a-mile the line passes down the principal street of Portrush, and has an extension along the Northern Counties Railway to the harbour. For the rest of the distance, the rails are laid on the sea side of the county road, and the head of the rails being level with the ground, a footpath is formed the whole distance, separated from the road by a kerbstone. The line is single, and has a gauge of three feet, the standard of the existing narrow gauge lines in Ulster. The gradients are exceedingly heavy, as will be seen from the diagram, being in parts as steep as 1 in 35. The curves are also in many cases very sharp, having necessarily to follow the existing road. There are five passing places, in addition to the sidings at the termini and at the carriage depôt. At the Bushmills end, the line is laid for about 200 yards along the street, and ends in the market-place of the town. It is intended to connect it with an electrical railway from Dervock, for which Parliamentary powers have already been obtained, thus completing the connection with the narrow gauge system from Ballymena to Larne and Cushendall. About 1,500 yards from the end of the line, there is a waterfall on the river Bush, with an available head of 24 feet, and an abundant supply of water at all seasons of the year. Turbines are now being erected, and the necessary works executed for employing the fall for working the generating dynamo machines, and the current will be conveyed by means of an underground cable to the end of the line. Of the application of the water-power it is unnecessary to speak further, as the works are not yet completed. For the present, the line is worked by a small steam-engine placed at the carriage depôt at the Portrush end. The whole of the constructive works have been designed and carried out by Mr. Traill, assisted by Mr. E. B. Price.

The system employed may be described as that of the separate conductor. A rail of T-iron, weighing 19 lbs. to the yard, is carried on wooden posts, boiled in pitch, and placed 10 feet apart, at a distance of 22 inches from the inside rail and 17 inches above the ground. This rail comes close up against the fence on the side of the road, thus forming an additional protection. The conductor is connected by an under-ground cable, to a single shunt-wound dynamo machine, placed in the engine shed, and worked by a small agricultural steam-engine of about 25 indicated horse-power, The current is conveyed from the conductor

by means of two springs, made of steel, rigidly held by two steel bars placed one at each end of the car, and projecting about six inches from the side. Since the conducting rail is iron, while the brushes are steel, the wear of the latter is exceedingly small. In dry weather they require the rail to be slightly lubricated; in wet weather the water on the surface of the iron provides all the lubrication required. The double brushes, placed at the extremities of the car, enable it to bridge over the numerous gaps, which necessarily interrupt the conductor to allow cart ways into the fields and commons adjoining the shore. On the diagram the car is shown passing one of these gaps; the front brush has broken contact, but since the back brush is still touching the rail, the current has not been broken. Before the back brush leaves the conductor, the front brush will have again risen upon it, so that the current is never interrupted. There are two or three gaps too broad to be bridged in this way. In these cases the driver will break the current before reaching the gap, the momentum of the car carrying it the 10 or 12 yards it must travel without power.

The current is conveyed under the gaps by means of an insulated copper cable carried in wrought-iron pipes, placed at a depth of 18 inches. At the passing places, which are situated on inclines, the conductor takes the inside, and the car ascending the hill also runs on the inside, while the car descending the hill proceeds by gravity on the outside lines.

From the brushes the current is taken to a commutator worked by a lever, which switches resistance-frames placed under the car, in or out, as may be desired. The same lever alters the position of the brushes on the commutator of the dynamo machine, reversing the direction of rotation, in the manner shown by the electrical hoist. The current is not, as it were, turned full on suddenly, but passes through the resistances, which are afterwards cut out in part or altogether, according as the driver desires to run at part speed or full speed.

From the dynamo, the current is conveyed through the axle-boxes to the axles, thence to the tyres of the wheels, and finally back by the rails, which are uninsulated, to the generating machine. The conductor is laid in lengths of about 21 feet, the lengths being connected by fish plates and also by a double copper loop securely soldered to the iron. It is also necessary that the rails of the permanent way should be connected in a similar manner, as the ordinary fish-plates give a very uncertain electrical contact, and the earth for large currents is altogether untrustworthy as a conductor, though no doubt materially reducing the total resistance of the circuit.

The dynamo is placed in the centre of the car, beneath the floor, and through intermediate spur gear drives by a steel chain on to one axle only. The reversing levers, and also the levers working the mechanical brakes, are connected to both ends of the car, so that the driver can always stand at the front and have uninterrupted view of the rails, which is of course essential in the case of a line laid by the side of the public road.

The cars are first and third-class, some open and some covered, and are constructed to hold twenty people, exclusive of the driver. At present, only one is fitted with a dynamo, but four more machines are now being constructed by Messrs. Siemens Bros., so that before the beginning of the heavy summer traffic, five cars will be ready; and since two of these will be fitted with machines capable of drawing a second car, there will be an available rolling stock of seven cars. It is not intended at present to work electrically the portion of the line in the town at Portrush, though this will probably be done hereafter; and a portion, at least, of the mineral traffic will be left for the two steam-tramway engines, which were obtained for the temporary working of the line pending the completion of the electrical arrangements.

Let us now put in a form suitable for calculation, the principles which Mr. Siemens has illustrated in a graphic form more convenient for the purposes of explanation, and then show how these principles have been applied in the present case.

Let L be the couple, measured in foot-pounds, which the dynamo must exert in order to drive the car, and w the necessary angular velocity. Taking the tare of the car as 50 cwt., including the weight of the machinery it carries, and a load of twenty people as 30 cwt., we have a gross weight of 4 tons. Assume that the maximum required is that the car should carry this load at a speed of seven miles an hour, on an incline of 1 in 40. The resistance due to gravity may be taken as 56 lbs. per ton, and the frictional resistance and that due to other causes, say, 14 lbs. per ton, giving a total resistance of 280 lbs., at a radius of 14 inches. The angular velocity of the axle corresponding to a speed of seven miles an hour, is 84

revolutions per minute. Hence L = 327 foot-pounds, and $w = \frac{2\pi \times 84}{60}$.

If the dynamo be wound directly on the axle, it must be designed to exert the couple L, corresponding to the maximum load, when revolving at an angular velocity w, the difference of potential between the terminals being the available E. M. F. of the conductor, and the current the maximum the armature will safely stand. This will be the case in the Charing-cross Electrical Railway. But when the dynamo is connected by intermediate gear to the driving wheels only, the product of L and w remains constant, and the two factors may be varied. In the present case L is diminished in the ratio of 7 to 1, and w consequently increased in the same ratio. Hence the dynamo, with its maximum load, must revolve at 588 revolutions per minute, and exert a couple of forty-seven foot-pounds. Let E be the potential of the conductor from which the current is drawn, measured in volts, C the current in ampères, and E_1 the E.M.F. of the dynamo. Then E_1 is proportional to the product of the angular velocity, and a certain function of the current. For a velocity Ω, let this function be denoted by $f(C)$. If the characteristic of the dynamo can be drawn, then $f(C)$ is known.

We have then

$$E_1 = \frac{w}{\Omega} f \qquad (1.)$$

If R be the resistance in circuit by Ohm's law,

$$C = \frac{E - E_1}{R}$$

$$= \frac{E - \frac{w}{\Omega} f(C)}{R}$$

and therefore

$$w = \frac{\Omega (E - C R)}{f(C)} \qquad (2.)$$

Let a be the efficiency with which the motor transforms electrical into mechanical energy, then—

Power required $= L\, w = a\, E_1\, C$

$$= a\, C \frac{w}{\Omega} f(C)$$

Dividing by w,

$$L = \frac{a\, C f(C)}{\Omega} \qquad (3.)$$

It must be noted that L is here measured in electrical measure, or adopting the unit given by Dr. Siemens in the British Association Address in Joules. One Joule equals approximately ·74 foot-pounds. Equation (3) gives at once an analytical proof of the second principle stated above, that for a given motor the current depends upon the couple, and upon it alone. Equation (2) shows that with a given load the speed depends upon E, the electro motive force of the main, and R the resistance in circuit. It shows also the effect of putting into the circuit the resistance-frames placed beneath the car. If R be increased until C R is equal to E, then w vanishes, and the car remains at rest. If R be still further increased, Ohm's law applies, and the current diminishes. Hence, suitable resistances are, first, a high resistance for diminishing the current, and, consequently, the sparking at making and breaking of the circuit; and, secondly, one or more low resistances for varying the speed of the car. If the form of $f(C)$ be known, as is the case with a Siemens machine, equations (2) and (3) can be completely solved for w and C, giving the current and speed in terms of L, E, and R. The expressions so obtained are not without interest, and agree with the results of experiment.

It may be observed that an arc light presents the converse case to a motor. The E.M.F. of the arc is approximately constant, whatever the intensity of the current passing between the carbons: and the current depends entirely on the resistance in circuit. Hence the instability of an arc produced by machines of low internal resistance, unless compensated by considerable resistance in the leads.

The following experiment shows in a striking form the principles just considered. An Edison lamp is placed in parallel circuit with a small dynamo machine, used as a motor. The Prony brake on the pulley of the dynamo is quite slack, allowing it to revolve freely. Now let the lamp and dynamo be coupled to the generator running at full speed. First, the lamp glows, in a moment it again becomes dark, then as the dynamo gets up speed, glows again. If the brake be screwed up tight, the lamp once more becomes dark. The explanation is simple. Owing to the co-efficient of self-induction of the dynamo machine being considerable, it takes a finite time for the current to obtain an appreciable intensity, but the lamp having no self-induction, the current at once passes through it, and causes it to glow. Secondly, the electrical inertia of the

dynamo being overcome, it must draw a large current to produce the kinetic energy of rotation, *i.e.*, to overcome its mechanical inertia; the lamp is therefore practically short-circuited, and ceases to glow. When once the rotation has been established, the current through the dynamo becomes very small, having no work to do except to overcome the friction of the bearings, hence the lamp again glows. Finally, by screwing up the brake, the current through the dynamo is increased, and the lamp again short-circuited.

It has often been pointed out that reversal of the motor on the car would be a most effective brake. This is certainly true; but, at the same time, it is a brake that should not be used except in cases of emergency. For this reason, the dynamo revolving at a high speed, the momentum of the current is very considerable; hence, owing to the self-induction of the machine, a sudden reversal will tend to break down the insulation at any weak point of the machine. The action is analogous to the spark produced by a Ruhmkorff coil. This was illustrated at Portrush; when the car was running perhaps fifteen miles an hour, the current was suddenly reversed. The car came to a standstill in little more than its own length, but at the expense of breaking down the insulation of one of the wires of the magnet coils. The way out of the difficulty is evidently at the moment of reversal to insert a high resistance to diminish the momentum of the current.

In determining the proper dimensions of a conductor for railway purposes, Sir William Thomson's law should properly apply. But on a line where the gradients and traffic are very irregular, it is difficult to estimate the average current, and the desirability of having the rail mechanically strong, and of such low resistance that the potential shall not vary very materially throughout its length, becomes more important than the economic considerations involved in Sir William Thomson's law. At Portrush the resistance of a mile, including the return by earth and the ground rails is actually about 0·23 ohms. If calculated from the section of the iron it would be 0·15 ohms., the difference being accounted for by the resistance of the copper loops, and occasional imperfect contacts. The E.M.F. at which the conductor is maintained, is about 225 volts, which is well within the limit of perfect safety assigned by Sir William Thomson and Dr. Siemens. At the same time the shock received by touching the iron is sufficient to be unpleasant, and hence is some protection against the conductor being tampered with.

Consider a car requiring a given constant current, evidently the maximum loss due to resistance will occur when the car is at the middle point of the line, and will then be one-fourth of the total resistance of the line, provided the two extremities are maintained by the generators at the same potential. Again, by integration, the mean resistance can be shown to be one-sixth of the resistance of the line. Applying these figures, and assuming four cars are running, requiring 4-horse power each, the loss due to resistance does not exceed 4 per cent. of the power developed on the cars; or if one car only be running, the loss is less than 1 per cent. But in actual practice at Portrush even these estimates are too high, as the generators are placed at the bottom of the hills, and the middle portion of the line is more or less level, hence the minimum current is required when the resistance is at its maximum value.

The insulation of the conductor has been a matter of considerable difficulty, chiefly on account of the moistness of the climate. An insulation has now, however, been obtained of from 500 to 1,000 ohms per mile, according to the state of the weather, by placing a cap of insulite between the wooden posts and T-iron. Hence the total leakage cannot exceed 2·5 ampères, representing a loss of three-fourths of a horse power, or under 5 per cent., when four cars are running. But apart from these figures, we have materials for an actual comparison of the cost of working the line by electricity and steam. The steam tramway-engines, temporarily employed at Portrush, are made by Messrs. Wilkinson, of Wigan, and are generally considered as satisfactory as any of the various tramway engines. They have a pair of vertical cylinders, 8 inches diameter and one foot stroke, and work at a boiler pressure of 120 lbs., the total weight of the engine being 7 tons. The electrical car with which the comparison is made, has a dynamo weighing 13 cwt., and the tare of the car is 52 cwt. The steam-engines are capable of drawing a total load of about 12 tons up the hill, excluding the weight of the engine; the dynamo over 6 tons, excluding its own weight; hence, weight for weight, the dynamo will draw five times as much as the steam-engine. Finally, compare the following estimates of cost. From actual experience, the steam-engine, taking an average over a week, costs—

	£	s.	d.
Driver's wages	1	10	0
Cleaner's do.	0	12	0
Coke, 58½ cwt. at 25s. per ton	3	13	1½
Oil, 1 gallon at 3s. 1d.	0	3	1
Tallow, 4 lbs. at 6d.	0	2	0
Waste, 8 lbs. at 2d.	0	1	4
Depreciation, 15 per cent. on £750	2	3	3
Total	£8	4	9½

The distance run was 312 miles. Also, from actual experience, the electrical car, drawing a second behind it, and hence providing for the same number of passengers, consumed 18 lbs. of coke per mile run. Hence, calculating the cost in the same way, for a distance run of 312 miles in a week—

	£	s.	d.
Wages of stoker of stationary engine	1	0	0
Coke, 52 cwt. at 25s. per ton	2	15	0
Oil, 1 gallon at 3s. 1d.	0	3	1
Waste, 4 lbs. at 2d.	0	0	8
Depreciation on stationary engine, 10 per cent. on £300, 11s. 6d.	2	0	4
Depreciation of electrical apparatus, 15 per cent. on £500, £1 8s. 10d.			
Total	£5	19	1

A saving of over 25 per cent.

The total mileage run is very small, on account of the light traffic early in the year. Heavier traffic will tell very much in favour of the electric car, as the loss due to leakage will be a much smaller proportion of the total power developed.

It will be observed that the cost of the tramway engines is very much in excess of what is usual on other lines, but this is entirely accounted for by the high price of coke, and the exceedingly difficult nature of the line to work, on account of the curves and gradients. These causes send up the cost of electrical working in the same ratio, hence the comparison is valid as between the steam and electricity, but it would be unsafe to compare the cost of either with horse-traction or wire-rope traction on other lines. The same fuel was burnt in the stationary steam-engine and in the tramway engines, and the same rolling stock used in both cases; but, otherwise, the comparison was made under circumstances in favour of the tramway engine, as the stationary steam-engine is by no means economical, consuming at least 5 lbs. of coke per horse-power hour, and the experiments were made, in the case of the electrical car, over a length of line three miles long, which included the worst hills and curves, and one-half of the conductor was not provided with the insulite caps, the leakage consequently being considerably larger than it will be eventually.

Finally, as regards the speed of the electrical car, it is capable of running on the level at the rate of 12 miles per hour, but as the line is technically a tramway, the Board of Trade Regulations do not allow the speed to exceed 10 miles an hour.

Taking these data as to cost, and remembering how this will be reduced when the water power is made available, and remembering such considerations as the freedom from smoke and steam, the diminished wear and tear of the permanent way, and the advantage of having each car independent, it may be said that there is a future for electrical railways.

We must not conclude without expressing our best thanks to Messrs. Siemens Bros. for having kindly placed all this apparatus at our disposal to-night, and allowing us to publish the results of experiments made at their works.

DISCUSSION.

Professor AYRTON, F.R.S., said the first thing which occurred to anyone on hearing this paper was that very much of the success which had been attained was due to the indomitable energy and perseverance of Dr. Siemens, and those associated with him in this enterprise. The first point to which he would refer, was the statement made by Mr. Siemens, that if you had a constant couple exerted by a motor, then the only thing which had to be changed, when you changed the speed, was the difference of potential at the terminals of the motor. Within certain limits, that law might be taken as true, but it was not true absolutely, as he feared some might suppose from the way in which it was stated. Experiments Professor Perry and the speaker had made with motors running at very varying speeds, from 900 up 4,000 revolutions, where the couple exercised was perfectly constant, did not show at all this constancy of current. Such a change of speed, made with a Gramme motor made of exceedingly soft iron, showed an increase of current of about 75 per cent., whilst the increase in the difference of potentials at the terminals was about 400 per cent. The next point, and the one which interested him even more than any other, was in regard to the insulation of the line, which, he gathered, amounted to only about 500 ohms per mile. He need hardly draw attention to the fact that that was an excessively small insulation, and what a loss there would be if the line, instead of being 6 miles, were 50 or 100 long. He therefore felt more convinced than ever of the truth of what he and Professor Perry had been saying for the last two

years, that it was impossible to work a long electric railway by any simple conductor of this kind; that, in fact, the only plan which he could see was the one they put forward some time ago, for only supplying the electricity to the portion of the line on which the tramcar was at the particular time—in other words, to diminish leakage by restricting it to a small portion of the line. Dr. Hopkinson had pointed out that the difficulty of gaps in the supply rail had been got over by trusting to the momentum of the train, but he was afraid that would not answer in the case of sidings where a train was going very slowly; in such a case as Crewe Junction, for instance, he should hardly like to trust to the momentum of a slowly moving train to get from one side of the station to the other. He should prefer to feel that he had some motive power which would carry him across. It could not be obtained if you had these long gaps in the supply rail. No doubt these were difficulties which Dr. Siemens would find the way to overcome, but they could hardly be said to have been quite swept away as yet, by the plans they had heard described to-night.

Mr. RECKENZAUN remarked on the absence of any mention of accumulators in this interesting paper. For tramways along crowded streets it would be impossible to use the rails as conductors, and there accumulators would come in. Very little practical results had yet been shown in this direction, but the scheme was quite practicable, and could also be shown to be economical. In the case of boats, again, it would be obviously impracticable to carry electricity by means of conductors, unless it were in the case of a ferry, where there was no other traffic.

Mr. BLOOMFIELD thought the application of this principle would be of enormous benefit to Ireland, which suffered more from want of means of communication than from anything else, as he had pointed out a few weeks ago in that room. When he found it stated by Dr. Hopkinson that the adoption of this principle would effect a saving of 25 per cent., and when Professor Ayrton had no other objection to bring against it except the difficulty of getting across the gaps, he was much encouraged. He was not a scientific man, but he thought by spending a little time over it he could get over the gap. He found the cost of railway maintenance on 14 lines in England was £28,000,000 per annum, and if you took 25 per cent. off that, you would save about seven millions per annum. That was something even for England to look forward to, but in Ireland it was of even greater importance. He was interested in a little railway between Donegal and Lough Erne, which would open up about 200 miles of fishery coast; they could not employ their own ocomotives upon it, and the Great Northern of Ireland would not work it for less than 60 per cent. He took it, that not only could the line be worked 25 per cent. cheaper by electricity, but also that not having such heavy locomotives, one-fourth might also be taken off the capital account for the construction of the permanent way, and also off the cost of maintenance. In Ireland speed was of no importance—communication was everything, and it appeared to him that this was one of the greatest blessings to Ireland he had heard of for a long time.

Professor AYRTON desired to correct an impression, which he seemed to have unintentionally conveyed to the last speaker, that he was at all antagonistic to electric railways. So far from that, he believed much of his future was bound up in them. What he wished to point out was that the per-centage of saving in this instance, arose in great measure from the line being so short, being practically only three miles, as there was a generator at each end. There were two things which would make an electric railway economical; one, the saving in the first cost of permanent way, and that was the main point in a country like Ireland, or in new countries. The other point was the saving in wear and tear. On the other hand, the disadvantage was, that the longer the line the greater was the waste of power by leakage. He feared that if Messrs. Siemens' line were thirty or forty miles long, with the same arrangements, instead of a saving of 25 per cent., there would be a considerable loss. But, on the other hand, if the good construction of the Portrush railway were combined with a superior method of insulation, such as Professor Perry and he had suggested, then he expected that even for long electric railways the saving would be equally marked, not to mention the advantage of having entire freedom from the possibility of a collision, which their method secured.

Mr. SCOTT MONCRIEFF said the sanguine hopes which had been expressed by Mr. Bloomfield led him to make a remark on what seemed to him the misleading comparison which had been made, if it was intended as a representation of railway traffic generally. The tramway engine with which the comparison was made was of a small and imperfect character, in which the consumption of fuel would probably be 5 lbs. or 6 lbs. of coke per horse-power per hour, whereas, when you took a locomotive on a large scale, you had a totally different condition of things, the consumption of fuel having been put as low as 2 lbs. If, therefore, the tables given were intended to show the comparison with an ordinary railway, they fell to the ground altogether, the every day locomotive being immeasurably more economical than either of the two methods described. In the locomotive, there was no loss of power by transmission, as was always the case with a stationary engine and a conductor. He feared, therefore, that Mr. Bloomfield's hopes were illusory, and that traffic would never be worked economically by electricity, excepting where the power could be obtained for nothing, as in the case of wind or water power. He had been interested in the comparison between the cost of working the tramway by steam and by

electricity, but the circumstances were exceptional, from the cost of fuel being so high. In a paper which he read in Manchester, in 1881, he made a comparison between the cost of compressed air and an ordinary locomotive engine, and his experience led him to the conclusion that the cost of working by compressed air was about the same as that now given for the electric tramway, viz., about 4d. per mile run.

Lord ALFRED CHURCHILL said this was a most interesting paper, and the experiments which had been shown demonstrated the marked advance in the applications of electricity. At the same time, he did not think they would ever see the railways of this country worked by electricity, for one reason, because there did not seem to be the means of attaining the speed to which we are accustomed. Some people talked of electricity as if it were a new power, forgetting that it was not a prime motor, but the power had to be derived from somewhere, and conveyed along the conducting wires to the place where it was wanted. No doubt it would be very valuable as a means of transmitting energy where there was water-power, or a stationary engine available; but in the case of steam-power, he believed there was a loss of about 40 or 50 per cent. in transmission, the result of which was that if you wanted 50-horse power for any particular purpose, you would have to use a 100-horse power engine to produce it. That seemed to him a sufficient reason for thinking it would never replace locomotives for ordinary railways, though it would, no doubt, be largely used for domestic purposes, and in small manufactories.

Mr. BLOOMFIELD asked whether, with available water power, an electrical railway could be expected to pay on a short line of railway in Ireland.

Mr. LIGGINS had been much struck with the electric hoist, and thought it would form a formidable competitor to the hydraulic power now commonly used in docks and wharves. It also appeared to him that such a thing would be very useful on board large sailing vessels, a small steam-engine being carried for the purpose of generating the power.

Mr. CUNNINGHAM suggested that a great loss of power might occur during heavy showers of rain, unless some covering were put over the conductor. He could not agree with the remark which had been made by a previous speaker, that the tables were upset because an economical engine would only use 2 lbs. of coke per horse-power. Besides, it was not intended to compare this electric tramway with a locomotive dragging a heavy tram, but with an ordinary tramway. Mr. Siemens claimed to have made an electric tramway cheaper than a steam tramway, which they all knew was cheaper than a horse tramway; and it was not fair to attack him because he had not beaten all the locomotives in the country. There were one or two points, however, in the tables, on which he should like a little further information. In the tramway-engine table, wages for driver and cleaner were given at £2 2s. together, but in the electrical table, only one stoker was charged at £1; it seemed to him there would be a driver or conductor required on the car, whose wages ought to be charged. Again, he did not know why twice as much waste was charged in one case as in the other; and, lastly, he was not at all sure that 15 per cent. depreciation was sufficient for the electrical plant. That was a point which was being very much discussed just now, and he believed there was a strong opinion that 15 per cent. was not enough.

Dr. J. HOPKINSON, F.R.S., said that the great advantage of electric railways would, no doubt, be seen in localities where water-power was available, as in the case in question; but the fact that the power could be applied to as many running axles as you pleased, was also of immense importance, as the cars could be made lighter, and consequently the bridges, works, and permanent way generally. It would also be advantageous in mountainous countries, on account of the steeper gradients which could be employed. The same consideration applied to elevated or overhead railways. He need not point out that there were other advantages in electric railways underground; and some of them looked forward to the day when London would be honeycombed with electric railways, as it now was with sewers. When, at some future day, electric railways obtained the full measure of success which many of them did not doubt would be reached, two names would be indissolubly associated with the movement, that of Dr. Werner Siemens of Berlin and of Dr. C. W. Siemens in England. Those gentlemen had not only had the foresight to foresee what was coming, but the energy to overcome the difficulties which had to be encountered, and the pluck to back their opinion, and carry electrical railways into actual operation.

Mr. SHOOLBRED said he had been interested to notice that Mr. Siemens had insisted very strongly on a point which he (Mr. Shoolbred) had mentioned two years ago, as a result of experiments he had made, viz., that the ratio between the electromotive forces of the two machines, the generator and the motor, was the important point to be considered. The question raised by Professor Ayrton, as to the loss of current by defective insulation, was a most important one in the working of electric tramways. It was not everywhere, besides, that a continous conductor could be put up, such as was the T-rail of the Portrush Railway. In cases where this loss of current became great, its transmission to a distance would have to be abandoned, and locomotion obtained direct from the stored current, drawn from accumulator cells. The loss in current must, however, be very considerable to counterbalance the carriage of the additional dead weight of the accumulators.

Dr. E. HOPKINSON, in reply, said he would first deal with the criticisms on the tables. The driver of the locomotive was a more skilled man than the

stoker who looked after the stationary engine, who was a mere labourer in fact, and ought to have been put down at 12s. a week instead of £1. In each case there were conductors to the cars to collect the money, &c., but he had omitted them from both tables. The fuel was undoubtedly high, and, as he had stated, on this account, the figures could not be compared with the cost of traction by compressed air, or a wire rope in other places. There was more waste required on the locomotive, because there was a greater surface to clean. The depreciation he had put down at 15 per cent. to be quite safe, but Dr. Siemens had had dynamos running for four years without requiring any repairs, except to the commutators, which was a very small matter. His own opinion was that instead of depreciation it ought to be appreciation, for it was quite certain that when the provisional orders were granted the price of copper would go up enormously. With regard to the use of accumulators, that was a very large field, and one quite different from the one they had occupied that evening; he hoped Mr. Reckenzaun would write a paper on the subject, and give the results of his experience. There was no doubt a large consumption of coke, but in the case of the electrical tram, the stationary engine was by no means economical, being an ordinary agricultural engine. He did not accept the figure of 2 lbs. per horse-power-hour as the consumption of a locomotive; the best stationary engine ever made consumed 1¾ lbs.; the best locomotives consumed about 4lbs. He could not answer Mr. Bloomfield's question definitely off-hand, but he should think a short branch line could be worked more economically by electricity than by steam. With regard to Professor Ayrton's objection, founded on the shortness of the line, he might say that when the experiments were made, over a great portion of the line there were no insulators to the conductor, if there had been, the figures given would have applied to a line thirty miles long. With regard to the gaps, it was evident that a separate conductor must be more economical where it could be adopted, and though gaps and sidings created a difficulty, they had managed to get over them. If Professor Ayrton's plan, which was carefully considered, had been adopted, the line would have had to be laid in sections of 50 yards. With regard to the illustration given of Crewe Station, he should say, have a separate conductor from London to Crewe, and when you got to the station, adopt Professor Ayrton's plan.

Mr. A. Siemens said Professor Ayrton spoke as if they believed that a separate conductor was the only possible mode to adopt; Mr. Reckenzaun was all for accumulators; but, in his opinion, a good engineer would always adapt himself to circumstances. It was proposed to use accumulators through the towns of Portrush and Bushmills, and if they could come to terms with Professor Ayrton, they might use his plan also on part of the line. Some inventors seemed to think that their particular plan would do everything, but a judicious combination of various plans would alone lead to success. He would not add anything on the fuel question except this, that if a good steam-engine were substituted for the travelling car, he ought also to substitute a good stationary engine for the agricultural engine now used. If the consumption of fuel were taken at 2 lbs. per horse-power in each case, there would still be a saving of 25 per cent. in favour of electricity.

The Chairman said he was surprised that no notice had been taken in the discussion of the first experiment which had been shown. When the electric mains were laid through the streets, they would all be very thankful to find that in those currents there was a means of throwing a volume of water 60 feet or more, as required. The discussion had turned entirely on the economical question, the question of efficiency being universally accepted as settled; for no one could leave that room entertaining any doubt that the power to work a railway by electricity was perfectly established. There only remained then the question of economy, and a further development of faith on the part of those who held the purse strings. In a locomotive there was not only an extravagant consumption of coal, but an enormous weight to be moved. But for this the permanent way might be much lighter and cheaper; and in towns like London there was also a very important consideration, the purity of the atmosphere. Two years ago, he was foolish enough to prophesy that the division of the electric current for lighting purposes was impossible, but now they saw it done in that very room; and he should not be at all surprised, if at no distant date, Lord Alfred Churchill also had to acknowledge that he had made a mistake in prophesying that electricity would not take the place of locomotives on our railways. He concluded by proposing a vote of thanks to Mr. Siemens and Dr. Hopkinson.

The motion was carried unanimously, and the meeting adjourned.

Correspondence.

SELF-PURIFICATION OF PEATY WATERS.

I have read Professor Hartley's paper on the "Self-purification of Peaty Waters," and the discussion thereupon in your *Journal*. Had I known that my own observations would have been specially called in question, I should have made a point of being present. Permit me, however, to say that on many points I am compelled absolutely to join issue with Mr. Hartley. That peaty matter is oxidized in running water (far less rapidly I admit

than animal matter) is, to my mind, a fact beyond all doubt. I only last week returned from a further careful inspection of the Shannon, and when the proper time comes, I shall deal with the difficulties raised by Mr. Hartley; and which, in my humble judgment, are capable of easy explanation.

C. MEYMOTT TIDY.

3, Mandeville-place, Manchester-sq., W.
April 8, 1883.

MEASUREMENT OF ELECTRICITY.

In the discussion which followed the reading of Mr. Shoolbred's paper upon "Electrical Measurement" on the 4th inst., Mr. Preece questioned the accuracy of a statement which I made to the effect that in the model clauses issued by the Board of Trade as a foundation for provisional orders under the Electric Lighting Act, a regulation existed under which the standard pressure in the mains might have different values at different hours of the day at the same place. Unfortunately, I had not the document in question with me at the meeting, but I explained that the clauses alluded to by me were, I thought, issued in December last.

I find on reference that in neither of my assertions had my memory deceived me. The memorandum is signed by the Permanent Secretary of the Board of Trade, and dated from the office on February 26th, 1883.

The clauses follow in detail, bearing, it is true, another signature (that of A. C. Meysey Thomson), but, of course, this is not intended to relieve the Board from the responsibility of their contents.

The memorandum begins:—"The following clauses are submitted for consideration as rough drafts of model clauses which are proposed to be inserted in provisional orders, and, so far as applicable in licenses granted under the Electric Lighting Act, subject to such modifications as local circumstances may in any case render expedient."

In the body of the clauses, under "Regulations as to Supply on the Parallel System," I read (first page of folio 18), (*c.*) "The standard pressure may be different for different points of any main, and for different hours during the period of supply, but it shall in all cases be within the limits following," &c.

I trouble you with this letter because the question, as one of fact, is of the highest importance to the public, and it is one of those points which will cause endless inconvenience if neglected in early legislation, and much expense in its final settlement by amendment.

I am represented in the report as stating that electric energy was made up of E.M.F. × time × quantity. What I said was that it is the product of E.M.F. × Quantity. This is the right expression, the *quantity* involving the time and the current.

THOMAS H. BLAKESLEY.

23, Fopstone-road, Earl's-court, S.W.,
April 5, 1883.

General Notes.

PRIZES OF THE PARIS ACADEMY OF SCIENCE.—The *Académie des Sciences* is authorised to accept a legacy left by M. Petit d'Ormoy, of Marolles en Hurepoix. It is to be invested in 3 per cent. *rentes*, the interest of which will go to found prizes for the applications of science to industrial, mechanical, and medical progress. The prize for mechanics, founded by General Poncelet, for the work most calulated to promote the advance of mathematical science, pure or applied, has, on the report of M. Bertrand, been awarded to M. Clausius for his works on mathematical physics. This prize is worth 2,000 francs (£40), to which is added, by a special donation of Mme. Poncelet, a complete edition of the General's works.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

APRIL 18.—"The Government Patent Bill." By H. TRUEMAN WOOD, B.A. Secretary of the Society. RICHARD E. WEBSTER, Q.C., will preside.

APRIL 25.—"Economy of Sanitation." By CAPT. DOUGLAS GALTON, C.B., F.R.S. ROBERT RAWLINSON, C.B., will preside.

MAY 2.—"Electricity as a Motive Power." By PROF. GEORGE FORBES.

MAY 9.—"English and Foreign Silver Work; with Some Remarks on Hall-markings." By WILFRED CRIPPS, F.S.A. Sir PHILIP CUNLIFFE-OWEN, K.C.M.G., C.B., C.I.E., will preside.

*** The reading of Mr. SEYMOUR HADEN'S paper, on "The Relative Claims of Etching and Engraving to rank as Fine Arts," previously announced for May 2, has been postponed until May 30th, when Sir RUTHERFORD ALCOCK, D.C.L., will preside.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings at Eight o'clock:—

APRIL 26.—"A New Process for the Separation and Recovery of the Volatile Constituents of Coal." By T. B. LIGHTFOOT, M.Inst.C.E. Sir H. HUSSEY VIVIAN, Bart., M.P., will preside.

MAY 24.—"The Development of Electric Lighting." By J. E. H. GORDON, B.A.

INDIAN SECTION.

Friday evenings at Eight o'clock:—

APRIL 20.—"The Fisheries of India." By Surgeon-General FRANCIS DAY. ANDREW CASSELS, Member of Council, will preside.

MAY 25.—"Some Notes on the Domestic Architecture of India." By C. PURDON CLARKE.

CANTOR LECTURES.

Monday evenings at Eight o'clock :—

Third Course, on "The Decorative Treatment of Metal in Architecture." By GEORGE H. BIRCH, A.R.I.B.A.

LECTURE III.—APRIL 16.

Iron Work (continued).—Germany—Augsburg and Nuremberg—15th and 16th centuries. England, 17th century.

Lead.—How used. Artistic treatment of the Middle Ages. Its capabilities.

Conclusion.—The use and abuse of metal work; modern bronze work; the decorative treatment of the metals, as applied in these days; our failures and successes.

Fourth Course, on "The Transmission of Energy." By OSBORNE REYNOLDS, M.A., F.R.S., Professor of Engineering at Owens College, Manchester.

LECTURE I.—APRIL 23.

General considerations relating to the transmission of energy; the transmission of energy requires power; the means by which, and the distances through which energy is transmitted in nature; the distribution of energy on the earth, and the means of concentrating and distributing it.

LECTURE II.—APRIL 30.

The storage of, and conveyance of stored energy in forms available for power; the limited capacity of all reservoirs of energy; the limits to the possible distance through which power may be transmitted by mechanical means.

LECTURE III.—MAY 7.

The transmission of energy through pipes and conductors; summary of economic considerations relating to the transmission of energy.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. G. H. Birch, "The Decorative Treatment of Metal in Architecture." (Lecture III.)

Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Mr. R. Warington, "Some of the Changes which Nitrogenous Matter undergoes within the Soil."

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Paper by Dr. Rassam.

TUESDAY, APRIL 10...Institute of British Carriage Manufacturers, Freemasons' Hall, Great Queen-street, W., 6 p.m. Mr. Henry Julian, "Interchangeability of Parts of Carriages."

Royal Institution, Albemarle-street, W., 3 p.m. Professor J. G. McKendrick, "Physiological Discovery." (Lecture III.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on Mr. P. O'Meara's Paper, "The Introduction of Irrigation into New Countries, as illustrated in North-Eastern Colorado."

Statistical, Royal School of Mines), 28, Jermyn-street, S.W., 7¾ p.m. Mr. Noel A. Humphreys, "The Recent Decline in the English Death-rate, and its effect upon the Duration of Life."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Prof. Flower, "The arrangement of the Orders and Families of Mammals." 2. Mr. F. Moore, "A Monogram of *Limnaina* and *Euplœina*, Two Groups of Diurnal Lepidoptera belonging to the Subfamily Euplœinæ, with Descriptions of New Genera and Species." (Part I. *Limnaina*.) 3. Mr. W. L. Distant, "Contributions to an Intended Monograph of the Homopterous Family Cicadidæ." (Part I.)

WEDNESDAY, APRIL 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. H. Trueman Wood, "The Government Patent Bill."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Hon. F. A. Rollo Russell, "Cirrus and Cirro-Cumulus." 2. George Attwood, "Notes on Waterspouts; their Occurrence and Formation." 3. Mr. W. W. Rundell, "Record of Bright Sunshine." 4. Edward T. Dowson, "Note on Wind, Cloudliness, and Halos; also on Results from a Redier's Barograph."

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Dr. Douglas Lithgow, "Saul near Down Patrick, with Reference to St. Patrick." 2. Mr. Thomas Morgan, "The Visit of the Country Associates to London."

THURSDAY, APRIL 19...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Sir John Lubbock, "Sense of Colour in the Lower Animals." 2. Prof. P. T. Cleve, "Diatoms of the Arctic Regions." 3. Rev. A. E. Eaton, "The Ephemeridæ or Mayflies." 4. Mr. J. Britton, "*Arum Italicum*."

Chemical, Burlington-house, W., 8 p.m. Ballot for the Election of Fellows. Mr. L. T. Thorne, "Note on an Apparatus for Fractional Distillation under Pressure."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Brinley Richards, "The Music of Wales, and the 11th Century MSS. in the British Museum." (With Selections of Music.)

Royal Institution, Albemarle-street, W., 3 p.m. Dr. Waldstein, "Art of Pheidias." (Lecture III.)

Royal Historical, 22, Albemarle-street, W., 8 p.m.

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. (Special Meeting.) Prof. F. A. Abel, "Electricity Applied to Explosive Purposes."

FRIDAY, APRIL 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Surgeon-General Francis Day, "The Fisheries of India."

Royal United Service Institution, Whitehall-yard, 3 p.m. Major Emilius Clayton, "The Russo-Turkish Frontier in Asia Minor."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. "The Island of Socotra."

Philological, University College, W.C., 8 p.m.

SATURDAY, APRIL 21...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Geikie, "Geographical Evolution." (Lecture III.)

Journal of the Society of Arts.

No. 1,587. Vol. XXXII.

FRIDAY, APRIL 20, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The third and last lecture of the course on "The Decorative Treatment of Metal in Architecture," was delivered by Mr. GEORGE H. BIRCH, on Monday, 16th inst. The lecturer concluded his remarks upon iron work, and specially referred to the fine specimens of work produced by the English blacksmiths of the 17th century, which are still occasionally to be seen. He then referred to the artistic treatment of lead in the Middle Ages, and dwelt upon the capabilities of that material. He concluded with some remarks on the use and abuse of metal work in the present day.

A cordial vote of thanks, on the motion of the CHAIRMAN (Mr. B. F. Cobb, Treasurer of the Society), was awarded to Mr. Birch, for his interesting lectures.

A large collection of works in wrought iron, consisting of gates, railings, lamps, galleries, and many other objects, were exhibited in illustration of the lecture, by Messrs. Gardner.

ADJOURNMENT OF MEETING.

The discussion on Mr. WOOD'S paper on "The Government Patent Bill" was adjourned on Wednesday, 18th inst., until Tuesday next, 24th inst., at 8 p.m. Mr. WEBSTER, Q.C., will again preside.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1883, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce." The following is a list of those to whom the medal has already been awarded :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.
In 1865, to his Imperial Majesty, Napoleon III.
In 1866, to Michael Faraday, D.C.L., F.R.S.
In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.
In 1868, to Mr. (now Sir) Joseph Whitworth, LL.D., F.R.S.
In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c.
In 1870, to Ferdinand de Lesseps.
In 1871, to Mr. (afterwards Sir) Henry Cole K.C.B.
In 1872, to Mr. (now Sir) Henry Bessemer, F.R.
In 1873, to Michel Eugène Chevreul, For. Me R.S., Member of the Institute of France.
In 1874, to Mr. (now Sir) William Siemens, D.C F.R.S.
In 1875, to Michel Chevalier.
In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal.
In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.
In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S.
In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S.
In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.
In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin.
In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

A full list of the services for which the medals were awarded was given in the *Journal* for March 9.

Members are reminded that to-morrow (21st of April), is the last day for receiving the names of such men of high distinction as they may think worthy of this honour.

Proceedings of the Society.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, April 12, 1883; Professor C. GRAHAM in the chair.

The paper read was—

THE FORMATION OF DIASTASE FROM GRAIN BY THE ACTION OF MOULDS.

By R. W. ATKINSON, B.Sc. (Lond.)

About two years ago, I presented a paper to the Royal Society, which bore, to an Englishman, the rather incomprehensible title, "The Diastase of Kôji." There was, perhaps, some excuse for the different ways

in which that title was rendered by various journals in their society announcements; one was given by someone who apparently imagined that *kôji* was a place, and that some dreadful event of scientific interest had happened there, for the announcement of the paper was "The Disaster of Kôji." Something to the same effect might, perhaps, be urged against the title I have chosen for the paper which the Council of the Society of Arts has done me the honour to request for the meeting of the Chemical Section to-night; I found, however, considerable difficulty in choosing one which should be sufficiently short, and, at the same time, explicit. After numerous trials I could find none better than "The Formation of Diastase from Grain by the Action of Moulds," which does express the essentially new fact that I wish to bring before you. And in order that there may be no thought of disaster on the part of anyone in this room, however little they may have considered the subject, I will ask permission, in the first place, to explain what I mean by diastase. If I take a quantity of thick starch-paste, formed from potato-starch by the addition of boiling water, I can invert the flask without the jelly escaping; but if I add to the flask a small quantity of a solution of malt, and keep the whole at a temperature of about 45°C. for a few minutes, you will find that the starch-paste becomes completely liquefied, and can be poured out like water. What is the cause of this change? Chemists assert that the malt-extract holds in solution a substance containing nitrogen, which possesses the remarkable property of causing thick, jelly-like starch-paste to lose its stiffness, to change into dextrin and a kind of sugar called maltose, and to change its optical characters; the body to which all these effects are attributed is called diastase. That sugar is formed under these circumstances I can show you very readily, by the use of a certain blue solution containing copper in the highest state of oxidation. When a little malt-sugar or grape-sugar is added to this boiling copper solution, it deprives the dissolved oxide of copper of a part of its oxygen, forming a less oxidised copper compound, which is red and insoluble. The change in the optical character of the liquid I am sorry I cannot show you, but it is very readily recognised by the use of such an instrument as I have here, very kindly lent me by Dr. Graham, from the collection of apparatus at University College. It is a polarimeter possessing a somewhat long name, with which I need not trouble you, and it is an instrument of the greatest value in researches upon the sugars and dextrins. All these various changes then are caused by the presence of diastase in the malt-extract, and we can hardly define it otherwise than as a nitrogenous body, which does act in the manner described. Little is known as to its composition; it has never been isolated in a pure form, though it may be obtained somewhat more concentrated than in the solution I have employed. There are bodies obtained from different sources which possess the same general characteristics, but we have no evidence to prove that they are identical. Indeed, in several cases, we know that they are not so. In saliva, there is present a substance which is found to act upon starch-paste, converting it into sugar, and altering its optical properties, just as malt-extract does, but its action, nevertheless, is specifically different. So, again, with the so-called ferment of the pancreas, which in most respects resembles the diastase of saliva. I can show you the action of saliva on starch-paste. On warming this starch-jelly with some filtered saliva, then adding a drop of the filtered fluid to the boiling copper solution, we get the red precipitate as in the former experiment. You may ask how these two forms of diastase differ from one another. I will try and explain. I must first mention that there are two kinds of sugar to which I shall have frequent occasion to refer to-night. Whilst in ordinary life the word "sugar" means only the sugar we find on our breakfast and tea-tables, or the sugar we use for sweetening fruit, chemists use it in a more general sense, and speak of "cane-sugar," that which is usually consumed; "grape-sugar," also called "fruit-sugar," and "glucose," found in grapes and in honey; and "malt-sugar," or "maltose," formed from starch by the action of malt. It is with grape-sugar and malt-sugar that I shall have to do to-night. The latter may be converted into the former, by causing it to combine with the elements of water, as, for instance, by boiling it with a dilute acid. In the pure state both are white, crystalline bodies, sweet to the taste, very soluble in water, but less soluble, and to different extents, in alcohol. The points of most importance in which they differ are, in the degree to which they reduce oxide of copper, and in their optical characters. Malt-sugar, or maltose, acts upon oxide of copper in such a way that it takes away only two-thirds of the amount of oxygen which the same

weight of grape-sugar will take away. The second point of difference is the degree to which they act upon a ray of polarised light. That we can determine by the aid of a polarimeter such as this. If we take two solutions containing in a given volume of the solution equal weights, the one of malt-sugar, the other of grape-sugar, and if we examine the ray of polarised light through columns of equal length, then the rotation in the two cases will be respectively as 150 : 59. By a combination of these two methods we have the means of ascertaining, with considerable accuracy, the composition of any liquid containing the two sugars.

Now the difference between the two kinds of diastase to which I have referred is this; the one, the malt-diastase, produces by its action on starch, as final product, malt-sugar, and no glucose; whilst saliva-diastase produces glucose. The malt-diastase, then, does not carry the hydration of the starch so far as the diastase of the saliva; it gets as far as maltose, and stops there; the saliva goes a step further, and hydrates the maltose, forming grape-sugar. This difference shows, then, that there are at least two distinct forms of diastase, but there may be a larger number, differing, perhaps, only in such slight degrees that they would be classed together.

Another point I may mention about diastase is that, apparently, it is formed in all cases from albuminoid matter, and that, like soluble albumen, it undergoes precipitation when heated. But here, again, different forms of diastase differ; some are precipitated, and in consequence lose their peculiar activity at lower temperatures than others. The diastase of malt is not killed, or rendered completely inactive, until heated to a temperature of 81° C., whilst the diastase to which I am about to draw your attention is destroyed at a temperature below 70° C.

Besides the sugars formed by the action of diastase upon starch, another substance is produced at the same time, having the same chemical composition as starch, but soluble in water. This is dextrin, or British gum, a body largely used in commerce for rendering adhesive the backs of postage stamps, and for thickening the compositions used in calico-printing. It is soluble in water, and much less soluble in alcohol than either of the two kinds of sugar I have mentioned, so that, from a solution containing both substances, they may be more or less perfectly separated by the use of alcohol.

When, therefore, we allow malt-diastase to act upon gelatinised starch, it causes it to become liquid, and there are produced two substances only, malt-sugar and dextrin. What change has the barley grain undergone that confers upon it this remarkable property? Most of you know that in the formation of malt from barley the essential change is of the nature of growth; the grain is first of all soaked, then is allowed to germinate until the plumule has attained a certain length, after which its vital activity is destroyed by withering and kiln-drying. It therefore passes through one part of the process of formation of a new plant; to feed the growing embryo, the starch and the albuminoid matter of the grain are drawn upon, and if the growth were allowed to go on long enough, the whole would disappear, leaving only the non-assimilable husk, as any one may prove for himself by pulling up a plant which has been in the ground for some time. In preparing malt, however, the change is arrested before very much of the food-stuff has been consumed; but, although not used up, the albuminoid matter has undergone a change, for whereas before germination the greater part was insoluble in water, after germination the larger portion is soluble. Chemists regard this albuminoid matter as reduced in complexity of structure, degraded, and, in that state, capable of effecting the transformation of starch into soluble bodies. Now, the question arises, is it always necessary to cause the grain to germinate, in order to obtain the albuminoid matter in the degraded state which seems to constitute diastase? In all the other cases mentioned above, in the formation of saliva and of the pancreatic juice, the degradation of the albuminoid matter is effected by the action of the living cells of the organism itself, and in that respect these liquids resemble malt; that is, the formation of diastase constitutes one stage in the development of a living organism.

There is an experiment which bears upon this point, which was shown in this room by our Chairman, in the course of the Cantor Lectures on "Bread-making." If you allow ordinary washed yeast to remain for an hour or so in contact with starch granules in presence of water, no solution of the starch takes place; the yeast-cell has not of itself the power to penetrate or destroy the wall of the starch-granule. If, however, you add to the mixture of starch and yeast a small quantity of some soluble albuminoid matter, which by itself would not act upon starch, such as a filtered aqueous solution of flour, and if you

leave the mixture for a similar time, then starch is dissolved. Although separately, neither the albuminoid matter added nor the yeast is able to attack the starch, yet, when they are in presence of one another, the yeast-cell so acts upon the albuminoid matter as to convert it into a form of diastase, and this then attacks the starch granule, dissolves the starch, and forms sugar and dextrin. We may, therefore, regard this as a case in which a foreign organism acts in a manner similar to the embryo of the barley, first attacking the nitrogenous substances, and then, with their aid, the starchy matter.

Everyone has noticed the formation of rotten wood, the way in which it gradually crumbles to pieces, and how various forms of fungi grow vigorously upon it. I take it that this is not because the wood was already rotten, and they have found a suitable soil for their growth, but rather that they themselves have produced the state of things we find; minute filaments of mycelium penetrate the interstices of the wood, act on the albuminoid matter, and thus ultimately cause complete decay. "Dry rot" is caused by nothing else but the growth of certain fungi, and, no doubt, if we took sufficient precautions, we might find that the soluble extract of such wood possessed diastasic properties, although in only a slight degree, owing to the small proportion of albuminoid matter contained in it.

M. Pasteur has described an exceedingly interesting example of the action which moulds or fungi exert upon nitrogenous matter. He took some pieces of moistened bread, placed them in a tube, cultivated various moulds upon them, and passed a slow current of air through the tube. After a time he obtained "torrents of ammonia" given off in the escaping gases, and, of course, carbonic acid was present, for this amounted in effect to a slow combustion of the starch and nitrogenous matter of the bread, through the influence of the moulds, the carbon and hydrogen producing carbonic acid and water, and the nitrogen forming ammonia with a portion of the hydrogen. He found that various species of moulds produced the same effects, and, doubtless, it is a property common to all.

This property of removing dead vegetable matter is well known to be possessed by moulds; they might indeed, be termed the scavengers of the vegetable kingdom, and it is a property which is of very great value. Pasteur thinks that it might be turned to account industrially; he mentions two cases in which this action is exerted—first, in the formation of vinegar from alcohol; and secondly, in the production of gallic acid from moistened nutgalls; but he was unaware of the extent to which advantage is taken of the limited action of moulds upon nitrogenous matter by those remarkable people, the Chinese and the Japanese, who are acquainted with many matters utterly unknown to us, notwithstanding our boasted superiority. It was whilst living in Japan that my attention was drawn to the process there employed to manufacture their alcoholic beverage, *saké*, and for a long time it seemed to me to be very obscure. For although they employed a grain, rice, they did not convert it as we do barley into malt, but commenced by completely destroying all vitality, first, by removing the skin and embryo by mechanical means; next, by steaming it. How then did they obtain the sugar necessary? I satisfied myself that no sugar was added, and that the only materials employed throughout the manufacture were the steamed rice, water, and a few fungus spores. The result of my observations was the discovery of the fact that diastase can be formed from the albuminoid matter of the grain by other means than by germination, and that one way is by allowing a mould to grow in contact with the grain. The vegetative part of the mould (mycelium) penetrates the substance of the grain, there acts upon the starch and nitrogenous matter, producing carbonic acid and certain soluble nitrogenous bodies, which convert starch jelly into sugar and dextrin—in fact, diastase.

In making these observations, I visited a great many breweries in different parts of Japan, and invariably I met with the greatest courtesy from the proprietors, who offered me every facility, and communicated every detail of the manufacture, even to the cost of the materials, with the greatest unreserve. It rather astonished many of them that a foreigner could find anything of interest in their processes, but I was able to interest them in turn by showing them, under the microscope, the ferment cells they were unknowingly employing. The usual expression of interest and astonishment—*naruhodo*—was repeated n every conceivable tone, and I could see, rom their incredulous glances, that they thought there was some delusion about it. As I was usually accompanied by some of my students, I have no doubt that a satisfactory conclusion was arrived at before we left. I am,

however, advancing somewhat too rapidly, for I wish first to describe shortly the process followed in manufacturing the material which provides the diastase, and which I propose, with your permission, to call by its Japanese name, *kôji*. The manufacture of this substance is the first stage in the brewing process, and it agrees—at least, so far as functions go—with our malt. Many breweries prepare their own *kôji;* but its preparation is best studied in the special works, for it is a substance the use of which is not confined to breweries, but it is used also in bread-making, and in the preparation of their sauce, "soy."

Mr. Kamayama, the proprietor of one of the largest works in the capital, Tôkiô, was good enough to allow me free access to them at any time, and further carried out experiments on the weights of rice used, and of *kôji* produced, which were of the greatest assistance to me. The chambers in which the manufacture is carried on are underground, long, narrow passages, cut at a considerable depth in the clay, so that they are practically unaffected by changes of temperature outside. Entering one of the chambers is like going into a mine. First, we descend a ladder; then, having reached the bottom, we crouch and feel our way along the low galleries, which have an atmosphere like a hothouse, moist and warm. Along two sides are ranged benches upon which trays containing the white *kôji* grains are supported, and, from time to time, the workman turns over the grains with his fingers. The temperature of these galleries varies very little; the limits of temperature, when most work is going on, are 79° to 84° F., as shown by a maximum and minimum thermometer. The oppressiveness of the atmosphere makes one anxious to get outside; and I will now describe briefly the treatment to which the rice is subjected. First of all, the rice is husked, then the grain, as found in commerce, has to be cleaned for the purpose of separating the thin outer skin. This is done by a rude process of beating in a mortar with a wooden mallet, the result of which is to break a large proportion of the grains, and also to detach the embryo. The broken grains are rejected, and the less damaged ones, used for making into *kôji*, are seen to have the broader end curved inwards, owing to the embryo having been detached. That being the case, it will readily be admitted that the grain could not germinate like our barley grain, and, therefore, to produce diastase from it, some other agency has to be involved.

The rice is soaked in water until soft, then steamed until the grains are flexible and horny-looking, the starch being gelatinised. We may therefore regard the grain of rice as now devoid of any vitality whatever, for a microscopic section would show that it had, to a great extent, lost its cellular structure, the granules of starch being broken up and forming a homogeneous mass of starch paste. When the rice has cooled down sufficiently, to about 82° F., the workman spreads it out on mats, then takes a small quantity, and mixes with it a spoonful of the spores of a fungus, and scatters the mixture over the remainder of the rice. By frequent handling, the spores are uniformly distributed, and the whole is then ready to be carried below. It is allowed to remain there in a heap for about two days, then is divided into small portions, and placed on the small wooden trays before mentioned. In this state they are left on the ground beneath the benches all night, and on the removal of the previous batch, at five a.m., they are placed on the top. During the night the temperature has been gradually rising, and by eight a.m. the small heaps on the trays have a temperature of 105° F., about 25° F. higher than that of the chamber. A reference to Tables I. and II. will show this. About this time the small heaps are spread out, and the temperature falls; then about ten a.m. they are heaped up again, and left until about one p.m., at which time the temperature has risen to a point nearly as high as at eight a.m. At that time the heaps are again spread out, and the temperature then falls continuously until five a.m. the following day.

No fire is used; the chamber is kept hot solely by the heat liberated during the growth of the fungus, and this growth is accompanied by the production of a large quantity of carbonic acid, which is removed by a current of air passing through the gallery up a small shaft, induced by the difference between the temperature of the chamber and that of the outer air. I have found by observation that the rice grain loses, in the form of carbonic acid and water, about 11 per cent. of its weight, which of itself is sufficient to account for the great heat evolved, and it shows that the growth is very energetic. It is as the result of this growth that the grain becomes a kind of malt, possessing diastasic properties, and this we shall see is due to the conversion of the insoluble albuminoid bodies

into soluble ones. Look at Table III., and compare the proportion of soluble albuminoids in rice and in *kôji* respectively; in the former, the amount in the insoluble form is nearly four times that in the soluble form; whilst in *kôji*, the soluble albuminoids amount on the average to four times the insoluble ones.

The variation in the amount of starch and sugar in the two specimens of *kôji* examined is easily explained by the longer time taken in making the solution of B than of A, as a result of which the diastase has formed more sugar at the expense of the starch in the former than in the latter. But the important point to notice is that the moulds, by feeding on the rice, have rendered soluble a large part of the nitrogenous matter, and thereby have produced a diastase. You will observe that the process of manufacture resembles Pasteur's experiment with bread—a current of air is caused to pass over the substance upon which moulds are cultivated; but in the manufacture under discussion, I was unable to detect the formation of any ammonia. The destruction of the nitrogenous matter, therefore, is less complete than in Pasteur's experiments, but on that account it is of greater practical utility. Perhaps, if a larger proportion of spores were employed, and the growth allowed to go on for a longer period, ammonia might be formed, but in this manufacture they avoid the fructification of the moulds by cutting short the time of growth. At the end of the season, when the maker wishes to renew his supply of spores, the process is allowed to extend for from seven to ten days, and it is the practice in such cases to add a certain quantity of wood-ashes, doubtless as a sort of manure, to render the growth more vigorous.

The external appearance of *kôji* is very different from that of malt. The soft and swollen grains of rice are bound together into lumps by fine, white, silky filaments, which give the whole a somewhat fluffy appearance when quite fresh. After having been kept some time, the grains become harder and drier, and partially separate from one another; if too long kept, decomposition sets in, the mass becomes yellow, and a kind of fermentation takes place, with the production of a fruity, ethereal smell. If the freshly prepared *kôji* is placed in contact with water, at about 45°C., for an hour or two, it may be almost wholly dissolved, nothing being left but the cellulose skeleton of the grain and mycelium. Treated with cold water, a considerable proportion dissolves, and on filtration, a golden-yellow solution is obtained, which possesses in a marked degree the activity characteristic of diastase. The action of water, under varying conditions, is shown in Table IV. The solution made in the cold is perfectly transparent, but if heated to about 55°C., it loses its transparency, owing to the precipitation of some of the albuminoid matter, and at the same time its diastasic activity is diminished, and may even be completely destroyed, if the temperature rises to 65°-70°C. Even at 60°C. it is very slight.

When we compare the process of making *kôji* with that of making malt, we are, first of all, struck with the difference that in the one case the grain is dead, and in the other is living; but beyond that, we are confronted with this fact that in both cases it is as the result of adding to the substance of living cells, that the nitrogenous matters are attacked and rendered soluble, and in consequence assume those characteristics by which we identify "diastase." In the case of the barley grain, it is the embryo which, by its growth, acts upon the starch, and upon the albuminoids; it is a part of the plant itself which effects the change; whereas, in the other case, it is a foreign plant which acts in an analogous manner. Are we, therefore, to assume that the products are identical? By no means. From the experiments I have made, it has been proved that this new form of diastase resembles that contained in saliva, and in the pancreatic juice, rather than that of malt. I have explained that it is in the nature of the ultimate products of the action of the diastase on starch-jelly that we distinguish between the two forms of diastase, and it is therefore to this reaction that I will now draw your attention, First of all, however, I must refer to a very important fact, viz.; the power possessed by a solution of the *koji*-diastase of transforming malt-sugar into grape-sugar, or glucose. It effects its conversion readily and completely, especially when heated to about 40°-45° C.; a curve drawn from the data in Table V. will show how regularly the specific rotatory power of the solution, that is its power of turning the plane of vibration of a ray of polarised light, diminishes when a solution of maltose is left in contact with a little extract of *kôji* at a temperature of 45°C, for two hours. The reason of this diminution in the specific rotatory power of the solution is that the maltose, which rotates the ray through 150°, is gradually converted, by combining with the

elements of water, into grape-sugar, which rotates the ray through only 59°.

From this preliminary experiment, it is evident at once that the diastase formed by the growth of a mould in contact with the rice grain, is not the same as malt-diastase, for I pointed out that the final products of the action of malt-extract on starch were maltose and dextrin.

When we come, therefore, to investigate the action of *kôji*-diastase upon starch we must expect to find grape-sugar as the sugar produced, and not maltose. This is the case, and with the considerable quantities of *kôji* used in my first experiments I was led to think that no maltose was formed. Malt-sugar is the first product, however, but it is so easily converted into glucose by *kôji* solution, that unless special care is taken to avoid too long a contact, its formation may be overlooked. The Tables VI. to IX., and the diagrams on the wall, will indicate the main points of interest in its action upon starch jelly. The diagrams illustrate in a graphic manner the amount of change which the starch undergoes, in a stated time, at a given temperature, by taking for comparison the diminution in the specific rotatory power, a property which is well fitted for the purpose. The amount of reduction is considerable; the starch may be assumed to have a specific rotatory power = 216°, which, by the action of the *kôji*-diastase, falls continuously to 59°, the number representing the specific rotatory power of glucose. That it does not fall so far in the experiments I have detailed in Tables VI. to IX., is due to the fact that the activity of the *kôji* becomes exhausted when small quantities are used, and that the more rapidly, the higher the temperature. It will be observed that at 10–15° C. the fall of the curve is comparatively slow, but nearly continuous; at 40° C. it is much more rapid, and very regular up to four and a half hours, then practically ceases, no doubt, because the *kôji* was then exhausted. At 45° C. the fall is very rapid during the first hour, after which the specific rotatory power remains nearly constant, until a fresh quantity of diastase is added; it then falls rapidly, showing that the first stoppage was caused by the destruction of the active properties of the diastase. Thus, the higher the temperature the more rapidly does conversion of the starch take place, but, at the same time, the activity of the diastase is destroyed more quickly, and this is shown in an exaggerated degree when the temperature employed is so high as 60° C. At that temperature, the fall in the curve ceases after less than half-an-hour, and on the addition of a fresh quantity of diastase (previously heated to the same temperature) a further fall occurs, lasting a little more than half-an-hour, and, no doubt, if fresh quantities of diastase had been added every half-hour, ultimately all the starch would have been converted into glucose.

I have now brought before you most of the known facts relating to this substance, but you may ask for more information respecting the nature of the mould which is used in this industry. Unfortunately, I am unable to give any exact information on this point; the spores employed do not appear to be homogeneous, and seem to consist principally of penicillium and mucors. The powder has a yellowish-green colour; it is probable that the effect produced is not characteristic of any particular species, but that almost any species would give rise to similar changes in the character of the albuminoid matter of the grain. This, however, is a point which yet remains to be worked out, and it may, perhaps, be found that each species produces a specifically different form of diastase, though that is not probable. Another point which yet requires investigation is the nature of the product resulting from the use of different kinds of grain. In one manufacture in Japan, that of the well-known sauce, "soy," they employ roasted wheat as the grain upon which the mould is cultivated; and although I have not examined into the question, it would appear that the product must possess properties identical with, or analogous to, those of rice-*kôji*. I had a specimen of barley submitted to the process I have already described, but whether the process had not been carried out properly, or for some other reason, I was not able to obtain a clear solution for examination, though I satisfied myself that it contained considerable quantities of sugar, more than ordinary barley would yield to water. I did not prosecute these experiments further, as I was at that time intent on the examination of the rice-*kôji*; but I have no doubt other grains could be employed as well as rice.

I have already stated that the *kôji*, prepared in the manner described, finds many uses in Japan; it is employed by bakers to form their yeast; and it is a somewhat curious circumstance that when a mixture of boiled rice, *kôji*, and water is kept in a warm place, a considerable formation of yeast takes place, just

as when our bakers make a mixture with German yeast for the same purpose. But the Japanese baker does not knowingly add any ferment; the probability is that yeast-cells are adherent to the grains of *kôji*, and, finding themselves in a saccharine medium, develop rapidly. But it is in the manufacture of *saké* that *kôji* is mainly used, and to illustrate the manner of its employment, and the mode of its action, I propose giving a brief account of that manufacture. I may premise that, as carried out in detail, it is very complicated; but as the minutiæ of the process have no influence in altering the general chemical reactions, I will merely mention the broad divisions of the process.

In the year 1880, the total amount of *saké* which contributed to the revenue was 200 million gallons, which, divided amongst the population, reckoned at 33 millions, shows that the average consumption per annum was only six gallons a head. Assuming that it contains twice as much alcohol as beer does, we see that in terms of beer each Japanese drinks only twelve gallons against the thirty-four gallons drunk in England. Nevertheless intoxication is not unknown in the Far East, and the process by which a man is led on from one glass to another is well expressed by the Chinese saying:—

> First the man takes a dram,
> Then the dram takes another dram,
> At last the drams take the man.

The manufacture appears to have been copied from the Chinese, but it has been known in Japan for several hundred years, and, so far as records go, it has undergone very little variation since its first introduction. There is a tradition that the district of Itami, which is the Japanese Burton, was selected on account of the quality of the water, and that other breweries were then grouped round about it. Whether this is so or not, the *saké* from Itami enjoys well-merited favour, and in almost any large tea-house in Japan you may hear the guests calling out for another cup of their favourite Itami.

The artificial divisions of the process at Itami are much more complicated than in other breweries, and as it would add very little to our understanding of the process to give them in detail, I will describe in preference the much simpler process followed in the capital, Tôkiô. All the rice employed undergoes the preliminary cleaning, soaking, and steaming, which I mentioned in describing the preparation of *kôji*, and the only materials employed are *kôji*, steamed rice, and water.

For the sake of clearness, I will divide the process into two parts, the first of which has for its object the preparation of an active yeast, and the second of which makes use of the yeast thus formed for the production of alcohol. Chemically speaking, it is hardly possible to separate them from one another, as the chemical reactions are the same in both, glucose and dextrin are formed in both, and the principal difference lies in the object that the brewer has in view.

For the preparation of the yeast, the brewer makes a mixture of steamed-rice, *kôji*, and water in such proportions that the whole mash contains about 38 per cent. of dry rice, and 62 per cent. of water. This mash is at first very thick, and would not fall out if the shallow tubs in which it is made were inverted. In these tubs it is stirred about every two hours, and gradually becomes liquid and sweet, owing to the action of the *kôji*-diastase upon the starch of the rice. During this time the temperature rarely rises above 10° C. (50° F.), and is usually much lower, all the operations of *saké*-brewing being carried out during the four coldest months of the winter, *i.e.*, November to February. The proportion which the *kôji* used bears to the steamed-rice is, both being reckoned in the form of dry rice, about 2 : 5; that is, two parts of rice made into *kôji* are mixed with 5 parts of rice, in the form of steamed-rice. The mash having become comparatively thin owing to the solution of the starch under the influence of the diastase, and being well aërated by the stirring, is emptied from the smaller tubs into a single larger one, in which its temperature is raised by the introduction of closed barrels containing hot water. The result of this is, that after a few hours a film forms upon the surface, carbonic acid gas is given off, and fermentation sets in, which goes on increasing until the coating of yeast on the surface is about an inch thick. I must repeat that the brewer does not consciously add anything like our yeast; but, nevertheless, as soon as the proper conditions as regards temperature are attained, a vigorous growth of yeast shows itself. It resembles in some respects the fermentation of the "must" in wine-making; and we know from Pasteur's researches that in that industry the yeast-cells are introduced into the "must" from the skins of the grapes. I am inclined to think that in this case something similar occurs. The germs, however, cannot come from the

rice which has been steamed only a short while before, but they may be adherent to the *kôji* which has been exposed to the atmosphere for some considerable time, and they may in part be derived from the vessels used.

Another explanation has been given, namely, that the filaments of mycelium which the *kôji* contains undergo a change when in contact with the liquid, by which they break up into cells, and then go on growing like yeast-cells. There is some justification for this view in the fact that the filaments of mycelium of some species of Mucor have been observed to break up in the above way; but no species has been found which is not killed in a liquid containing 5½ per cent. of alcohol, whilst this *saké*-yeast lives in liquids containing 12 and 13 per cent. of alcohol. There are several other reasons why I believe that the yeast is air-sown, and not derived from the mycelium; but it would occupy too much time to enter into a discussion of the question at the present time. Only one point I may direct attention to, and that is, that from the beating the mash received before being warmed, it must be perfectly aërated, and that, we know, is a condition unfavourable to the conversion of the mycelium into a sub-aqueous ferment.

After the growth of yeast has become sufficiently vigorous, the mash, the temperature of which has risen to 23° C. (73°·4 F.) is allowed to cool down, and the first stage of the manufacture is ended. The length of time occupied by this stage varies in different places, but it may be taken at 12 to 15 days. The chemical changes undergone by the mash are shown in Tables X. and XI., the former showing the composition before heating, and the latter the changes subsequent. Before being heated, the starch is dissolved, being reduced from 32·17 per cent. to 20·43 and 15·46 per cent. on the third and fifth days respectively, whilst the glucose increases to 7·35 and 12·25 per cent. On the fifth day the mash was warmed, and we see the effect on the subsequent days in the large production of alcohol, and the diminution in the glucose; the starch also undergoes a further solution at the same time that the sugar is being converted into alcohol. There is a slight variation in the amount of starch left undissolved in Table XI., which arises from the extreme difficulty of getting an average sample from such a mash. The dextrin diminishes, but does not entirely disappear, and there is at the same time acid formed. This the brewer recognises, for one of the five tastes which the mash at the end of the first stage ought to have is a sour taste.

Having thus obtained a quantity of vigorous yeast, the main part of the process remains to be carried out, and though now the object of the brewer is to obtain alcohol and not yeast, the mixtures made are very nearly the same, differing only slightly in the proportions used. Further, all the material is not added at one time, but mixtures are made from time to time, and it is the number of different mixtures made which complicates the process so much at Itami. The ultimate result is that the proportions of dry rice and water used are as 1 : 2. Table XII. shows that in proportion as the starch is dissolved alcohol is formed, and that at no period is any considerable quantity of sugar present in solution. As fast as the sugar is formed by the solution of the starch, it is converted into alcohol, until on the last day there is practically no sugar in solution, less than half a per cent. of dextrin, rather more than two per cent. of glycerine, albuminoids, and acids, and more than thirteen per cent. of alcohol. One point in which this process differs from our methods of brewing lies in the continuous solution of the starch throughout the whole fermentation. Whereas in making beer a certain quantity of starch and dextrin are obtained in the worts, and the diastase of the malt is destroyed by boiling, so that no fresh starch can be dissolved, in *saké*-making the brewer keeps adding throughout fresh quantities of diastase to replace that which is exhausted. It is no doubt owing to this variation that the liquid is so completely "attenuated," as our brewers would say, for even the dextrin has been fermented. The result is a very thin, highly-alcoholic liquid, specimens of which, preserved by "Pasteurization," are upon the table.

In Table XII. I have given the composition of the filtered *saké*—that is, the mash which has been strained from the insoluble residue—and it will be observed that the per-centage of alcohol is considerably reduced. This arises from the addition of water by the brewer in rinsing out his tubs. The filtration is effected by pouring the mash into hempen bags, which are closed and then placed in a kind of press. As it passes through, the liquid is turbid, and it is cleared by standing. The clarified *saké* is afterwards heated and preserved in large sealed tuns. Table XV. will give an idea of the composition of the best kinds of *saké* from Itami and from Nishinomiya, another celebrated district not far from Itami. The

specimens upon the table are from the Itami brew of 1879-80, and have been preserved by "Pasteurization"—that is, heating in bottles to a temperature of 60° C., after which they were sealed to preserve them from contact with air. In Japan, during the summer months, the *saké* turns undrinkable unless frequently heated, and consequently has not hitherto been kept from year to year. Indeed, I believe that the specimens before you are the only ones which have attained such a respectable age as three years. The spoiling of the *saké* is due to the development of butyric and lactic acid ferments; and an observation I have made bears somewhat upon the experiment of M. Pasteur, to which I made allusion in an early part of this paper. Samples of *saké* which had been kept in ordinary stoppered bottles throughout the summer, I found to have become strongly charged with carbonic acid gas, effervescent, whilst ordinarily it is perfectly "still." At the same time they possessed a disgusting odour, and, mixed with others, the smell of ammonia was very strong. Here, then, was an example of the more thorough combustion of the albuminoid matters under the influence of fungi. If, however, care be taken to preserve the liquid from contact with air, after having been heated, the *saké* may be kept for a long time.

I have described the Japanese brewing process, as it forms the most important example of the industrial application of the diastase which is formed from grain by the growth of moulds upon it. Like many other things, moulds may be good servants but bad masters; and to illustrate that, I need do more than refer to the disastrous effects produced by damp weather on grain, how it becomes mouldy, and in some cases poisonous, from their presence. We cannot, therefore, refuse to attach some importance to the question of the action of moulds upon various substances, from the point of view of practical applications. I have been able to lift only a very small corner of the veil which hides our ignorance of the action of moulds. I have mentioned one or two points which remain to be examined in connection with grain, and I may be permitted to refer to another case which would no doubt well repay investigation. It is a matter of common observation that mouldy cheese is possessed of somewhat active digestive properties; is that due to the formation of diastase in the cheese by the action of the moulds upon the casein? In the ripe state, of course, the moulds have already fructified; but, during the ripening of such kinds of cheese, may it not be that an action goes on similar to that I have described in the manufacture of *kôji*? This can only be answered by further experiment, and I am satisfied at present with having suggested the problem.

The examples already given, the rotting of wood, the formation of ammonia from the albuminoids of bread and of *saké* by moulds and bacteria respectively—the action of yeast-cells in presence of soluble albumen upon starch, and the formation of diastase from dead-rice grain by the growth of moulds, are sufficiently numerous to show that the fungi play a very important part in the economy of nature, and that it behoves us to study such cases carefully, that we may add both to our stock of scientific knowledge and to our industrial processes.

APPENDIX.

TABLE I.—TEMPERATURES OF KÔJI AND CHAMBER IN DECEMBER. KÔJI OF THE THIRD DAY ONLY.

Date.	Hour.	Temperature of outer air.	Temperature of air in chamber.			Temperature of kôji (third day).
			Maximum.	Minimum.	Observed.	
		°F.	°F.	°F.	°F.	°F.
December 5th	8 a.m.	40·7	—	—	82	104·8
,, ,,	2 p.m.	49·5	82	83	82	91·9
,, ,,	8 p.m.	42·5	81	83	81	88·8
,, 6th	8 a.m.	41·5	80	83	83	106·6
,, ,,	10 a.m.	44·7	81·6	82	81·6	101·0
,, ,,	1 p.m.	50·0	81	82·5	81·5	104·
,, 7th	9 a.m.	38·5	80	82·5	81·5	104·2
,, ,,	2 p.m.	51·0	80·5	82	81·5	93·6
,, 8th	8 a.m.	37·5	79	82·5	80	100·0

TABLE II.—TEMPERATURE OF KÔJI ON THIRD DAY.

Hour.	Dec. 5th.	Dec. 6th.	Dec. 7th.	Dec. 8th.
	°F	°F	°F	°F
8 a.m.	104·8	106·6	...	100·0
9 a.m.	...	...	104·2	...
10 a.m.	...	101·0	...	...
1 p.m.	...	104·0	...	...
2 p.m.	91·9	...	93·6	...
8 p.m.	88·8	...	...	...

TABLE III.—PER-CENTAGE COMPOSITION OF WHITENED RICE AND KÔJI FORMED FROM IT, BOTH DRIED AT 100° C.

		Sample A.		Sample B.	
		Rice.	Kôji.	Rice.	Kôji.
		Per cent.	Per cent.	Per cent.	Per cent.
Insoluble in Water.	Starch	82·27	56·00	82·14	26·20
	Cellulose	4·79	4·20	3·02	1·94
	Fat	·49	·43	1·12	·50
	Ash	·46	·09	·16	·04
	Albuminoids	7·50	1·50	8·82	1·83
Soluble in Water.	Albuminoids	1·95	8·34		6·40
	Dextrose	...	25·02	...	58·10
	Dextrin	1·91	3·88	3·97	4·41
	Ash	·63	·52	·77	·54
		100·00	99·98	100·00	99·96
Water in original sample		12·70	25·82	12·19	28·10

TABLE IV.—AMOUNT OF SOLID MATTER DISSOLVED BY WATER, FROM 100 GRAMS OF KÔJI AT 10—15° C.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.
No.	Volume of water used.	Time.	Weight of solid matter in solution.	Average weight of solid matter.	Per cent. of dextrose in solid matter.	Specific rotatory power.	Average specific rotatory power.
	c. c.	hrs.					
1	500	12	17·7		60·0	65°	
2	1,000	18	25·7			61°	
3	,,	,,	24·2			55·7	57°·6
4	,,	,,	23·0			56·0	
5	,,	12	33·3		49·0	65·3	
6	,,	,,	33·3		50·9	65·4	
7	,,	,,	29·4	27·0	45·0	62·9	
8	,,	,,	28·6		46·5	67·7	64°·6
9	,,	,,	26·8		53·0	61·4	
10	,,	,,	22·5		53·0	64·5	
11	,,	,,	22·2		54·0	65·0	
12	,,	4	28·0			61·4	
13	2,000	3	31·1		68·0	78·0	
14	2,500	,,	32·2		58·0	68·1	
15	,,	,,	32·5	31·4	70·0	65·2	69°·3
16	,,	,,	30·7		65·0	73·8	
17	,,	,,	30·1		68·0	70·2	
18	5,000	24	30·0		47·0	64·5	
19	10,000	,,	40·0		66·0	60·5	

TABLE V.—ACTION OF KÔJI EXTRACT UPON MALTOSE.

Time.	Solid matter in 500 c.c. after deducting kôji	Rotation after deducting kôji	Specific rotatory power of maltose product.
10 min.	2·826	5·8 div.	124°·2
30 ,,	2·886	5·3 ,,	111°·1
1 hr.		4·7 ,,	98°·5
2 ,,		3·7 ,,	77°·6

TABLE VI.—ACTION OF KÔJI EXTRACT UPON STARCH AT 10—15° C. 10 GRAMS OF STARCH TO 10 GRAMS OF KÔJI.

Time.	Total starch products in solution (kôji deducted).	Specific rotatory power of starch products.
	Grams.	
½ hour	10·61	172°·8
2 hours	10·45	158°
21½ ,,	10·56	131°
26 ,,	10·65	120°·4
46 ,,	10·51	110°·5

TABLE VII.—ACTION OF KÔJI EXTRACT UPON STARCH AT 40° C. 10 GRAMS OF STARCH TO 10 GRAMS OF KÔJI.

Time.	Total starch products in solution (kôji deducted).	Specific rotatory power of starch products.
	Grams.	
⅓rd hour	9·64	143°·1
1 ,,	9·64	127°
2 hours	9·64	115°
3 ,,	9·65	105°
4½ ,,	9·67	88°
6 ,,	9·69	86°
+20 hrs. at 15° C.	9 79	80°

TABLE VIII.—ACTION OF KÔJI UPON STARCH AT 45° C. 10 GRAMS OF STARCH TO 10 GRAMS OF KÔJI.

Time.	Total starch products in solution (kôji deducted).	Specific rotatory power of starch products.
	Grams.	
5 min.	9·48	142°·6
25 ,,	9·93	126°·3
1 hr.	9·93	106°
1½ ,,	—	103°·6
2 ,,	9·98	103°
3 ,,	9·98	98°·3
4 ,,	—	98°·3
⅛th more kôji added.		
4½ hrs.	10·18	88

TABLE IX.—ACTION OF KÔJI EXTRACT UPON STARCH AT 60° C. 10 GRAMS OF STARCH TO 10 GRAMS OF KÔJI.

Time.	Total starch products in solution (kôji deducted).	Specific rotatory power of starch products.
	Grams.	
5 minutes	9·70	182°·1
15 ,,	,,	180°·2
30 ,,	,,	168°
1 hour	,,	168°
1½ ,,	,,	164°·6
1¾ hr. fresh addition		
2 hours	10·19	145°·8
2½ ,,	,,	131°·8
3 ,,	,,	128°·2
3½ ,,	,,	131°·8
4 ,,	10·19	131°·8

TABLES ILLUSTRATING THE CHANGES IN COMPOSITION WHICH THE MASH UNDERGOES IN SAKE-BREWING.

TABLE X.

	At commencement.	Third day. 8 a.m.	Fifth day. 8 a.m.
	Per cent.	Per cent.	Per cent.
Dextrose	...	7·35	12·25
Dextrine	...	5·12	5·69
Glycerine, ash, albuminoids	...	trace	·48
Fixed acid	...	·017	·019
Volatile acid	...	...	·008
Water (by difference)	100·00	87·513	81·533
	100·00	100·000	100·000
Starch undissolved	32·17	20·43	15·46
Specific gravity of mash	...	1·15	1·18
Temperature	...	13° C.	10° C.
Specific rotatory power	...	124°	106°

TABLE XI.—COMPOSITION OF THE MASH FROM THE SEVENTH TO THE FOURTEENTH DAY.

	7th day.	10th day.	12th day.	14th day.
	Per ct	Per ct.	Per ct.	Per ct.
Alcohol	5·2	8·61	9·41	9·20
Dextrose	5·4	·99	·49	·50
Dextrin	7·0	2·81	2·72	2·57
Glycerine, ash, albuminoids, &c.	1·14	2·82	2·35	1·93
Fixed acid	·31	·24	·31	·30
Volatile acid	·15	·11	·05	·03
Water (by difference)	80·80	84·42	84·67	85·47
	100·00	100·00	100·00	100·00
Specific rotatory power	135°	100°·7	111°·6	116°
Specific gravity of mash	1·08	1·05	1·06	1·04
Temperature of mash	23°C.	14°C.	10°C.	9°C.
Starch undissolved	10·68	12·46	11·55	12·05

TABLE XII.—COMPOSITION OF THE MASH DURING THE PRINCIPAL PROCESS.

	17th day.	19th day.	21st day.	24th day.	28th day.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cen
Alcohol	5·80	9·44	11·83	12·41	13·2
Dextrose	2·06	1·16	·27	·27	0
Dextrin	3·89	2·74	1·42	·47	·41
Glycerine, albuminoids, &c.	·04	1·09	1·98	1·68	1·99
Fixed acid	·02	·03	·058	·086	·107
Volatile acid	...	...	·029	·086	·061
Water	88·19	85·54	84·413	84·998	84·202
	100·00	100,00	100,000	100·000	100·000
Specific rotatory power	160°	132°·3	88°·8	48°·2	36°
Specific gravity of mash	1·03	1·017	0·994	0·990	0·98
Temperature of mash	19°	25°C.	26°·C.	20°C.	12° C.
Undissolved starch	12·81	7·85	5·534	5·40	4·1

TABLE XIII.—COMPOSITION OF FILTERED SAKE.

Alcohol	11·14 per cent.
Glycerine, resin, &c.	1·99 ,, ,,
Fixed acid	·13 ,, ,,
Volatile acid	·02 ,, ,,
Water (by difference)	86·72 ,, ,,
	100·00
Specific gravity	0·990

TABLE XIV.—COMPOSITION OF THE PRESSED RESIDUE.

Soluble solids	1·43 per cent.
Starch and cellulose	32·07 ,, ,,
Ash	·70 ,, ,,
Alcohol	6·00 ,, ,,
Water	59·80 ,, ,,
	100·00

DISCUSSION.

The CHAIRMAN thought the subject, although a very technical one, must have very much interested them all, and he should be glad to hear any remarks or suggestions upon the very able and instructive paper to which they had just listened.

Mr. T. W. LOVIBOND said it might probably be due to his inattention, but he had failed to gather how long the second or re-fermentation lasted. He understood that the first stage of the process described took from twelve to fifteen days, but he did not remember hearing how long the second stage lasted, nor about the temperature.

TABLE XV.—COMPOSITION OF VARIOUS SPECIMENS OF SAKÉ FROM ITAMI AND NISHINOMIYA.

	Itami.				Nishinomiya.				
Name of Saké.	"Gaika."	"Hatsu-hikage."	"Shira-yuki."		"Iro-zakari."	"Tai-riyo."	"Saki-gake."	"Kôme-ichi."	"Zui-ichi."
Name of Brewer.	Konishi Shin-yemon.	Konishi Shin-yemon.	Konishi Mote.		Idzumi Man-suke.	Tatsu Gonuske.	Tatsu yasu.	Tatsuma Kijiro.	
Alcohol	12·30	12·15	12·15	13·10	13·73	11·20	12·83	11·00	13·50
Dextrose	·62	·312	·44	·56	·404	—	·82	·20	1·41
Dextrin	·255	·256	·30	·05	·18	·16	·22	·14	·39
Glycerin, ash and albuminoids	1·530	2·15	1·857	1·46	1·833	1·81	1·22	1·58	2·02
Fixed acid	·145	·13	·123	·32	·143	·12	·32	·13	·24
Volatile acid	·015	·01	·032	·03	·026	—	·014	·014	·013
Water (by difference)	85·135	84·992	85·098	84·48	83·684	86·71	84·576	86·936	82·427
.	100,000	100·000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Specific gravity	0·991	0·992	0·992	0·993	0·989	0·990	0·990	0·991	0·994
Specific rotatory power	36°	25°·6	33°	19°·7	24°	16°·4	37°	20°·6	41°·6

Professor ATKINSON said the length of time was about the same in both stages of the process, and the temperature was given in the diagram.

Mr. LOVIBOND wished to add that the subject was one of very great interest. Of course, they had not much data on which to form an opinion, but he could scarcely think that the formation of the yeast was accidental, even in the sense that the wine ferment was accidental, the germ of which was on the skins of the grapes. It seemed to him highly probable that the yeast organism which had been referred to was the result of the growth of mycelium under new conditions. Mr. Atkinson had said that one reason for thinking the yeast or ferment was not an alteration in the growth of the mycelium or mould that existed before was, that such ferment was killed by a solution containing 5 or 5½ per cent. of alcohol; and another reason he had given was that the condition of aëration was antagonistic to the conversion of the mycelium into a subaqueous ferment. But some people supposed that brewers' yeast was simply a change from an air-living organism to a submerged one; and it was well known that 5 per cent. of alcohol would not destroy the action of brewers' yeast, and aëration rather increased its action than destroyed it.

The CHAIRMAN said the paper opened out a field of very important research, and, so far as he knew, Professor Atkinson was the very first to study the peculiar action of moulds upon albuminoid bodies. There was no doubt that mankind had, for a considerable time, supposed that a small piece of rich cheese was a good thing to take after a heavy dinner; but, curiously enough, the nature of the change brought about by the action of the moulds had not been investigated. So far as he could understand, even Mr. Atkinson had not yet made use of various forms of decomposed cheese to investigate the action of moulds upon amylaceous bodies, and also substances like meat; but there was no doubt that that was a field of inquiry which would give very important information, useful not only in the arts, but in dietetics. The Japanese were not the only people who had recourse to spontaneous germination. The Belgians had, for a great number of years, submitted their wort to spontaneous fermentation; but in no case was it possible to obtain a liquid so excessively rich in alcohol as the *saké*, which had been described. It was probably due to its aërial history that the ferment used by the Japanese was so much more active than the yeast used in this country which had lived a sub-aërial life of many generations. He should like Professor Atkinson to say that he would investigate whether the moulds on cheese and such bodies produced some important change in the albuminoids, such as he had demonstrated were brought about in the process he had so ably described.

Professor ATKINSON said it was a matter of extreme difficulty to say with certainty what was the origin of the fermentation in that particular case. He had merely expressed his own opinion, and of course was not able to say positively that the organism was not derived from the mycelium. In calculating the yield of alcohol, he had assumed that the ratio of alcohol to carbonic acid was the same as that in ordinary fermentation, although he found in the manufacture of the alcohol, they only succeeded in converting from 50 to 60 per cent. of starch into alcohol, so that there was a loss of at least 40 per cent. of starch in the process, and that did not seem to be in the residues. He could not promise to investigate the action of the moulds in cheese, but hoped he might be able to do so.

The CHAIRMAN then proposed a vote of thanks to Professor Atkinson for the very interesting and instructive paper that he had read, which was carried unanimously.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 18th, 1883; RICHARD E. WEBSTER, Q.C., in the chair.

The following candidates were proposed for election as members of the Society:—

Bain, Richard Donald, Stow-park, Newport, Monmouthshire.
Craven, Thomas Fewsdale, Birkby-house, Westbourne-road, Sheffield.
Monnery, Edward John, 165, Fenchurch-street, E.C., and Greenbank, Lingard's-road, Lewisham, S.E.
Wells, Frederick Arthur, Springfield, Chelmsford.
Wharton, Charles Joseph, 8 and 9, Holborn-viaduct, E.C.

The following candidates were balloted for and duly elected members of the Society:—

Barry, William, J.P., Mayor of Scarborough.
Cowper-Coles, C.B., 95, Wigmore-street, W.
Darby, George Frederick, 149, Upper Thames-street, E.C.
Davis, William J. Leach, The Grammar School, Maidstone.
Galloway, John, jun., Knott Mill Iron Works, Manchester.
Greenup, William Thomas, The Avenue, Cambridge.
Hansell, Robert Blackwell, Moor Oak's-road, Broomhill, Sheffield.
Harland, Arthur, 170, Stanhope-street, N.W., and The Polytechnic, Regent-street, W.
Harris, Alfred Edwin, 14, The Avenue, Sunderland.
Hawkes, Charles Samuel, Stoneleigh, Beckenham, Kent.
Hollins, William, 5, Queen's-gate-place, S.W., and Pleasley-vale.
Phillips, Charles Henry, 387, Mare-street, Hackney, E.
Pole, Thomas, 2, Beaconsfield-road, Clifton, Bristol.
Pratt, Thomas, 24, Tavistock-street, Covent-garden, W.C.
Rainger, Charles Henry, 9, Bath-place, Cheltenham.
Spruce, Samuel, Beech-house, Tamworth.
Stephens, Major Edmund, R.E., Junior United Service Club, S.W.
Swan, Henry F., North Jesmond, Newcastle-on-Tyne.
White, Arnold, Devonshire Club, S.W.
White, Robert Blake, 23, Anerley-park, Anerley, S.E., and Medellin, United States of Colombia, South America.
Wilson, Hugh, 9, New Broad-street, E.C., and Chesterleigh, Beckenham, Kent.
Wood, Thomas, Ebbw-vale Works, Monmouthshire.

The paper read was—

THE GOVERNMENT PATENT BILL.

By H. TRUEMAN WOOD, B.A.,
Secretary of the Society of Arts.

The members present are, doubtless, aware that there are now before the House of Commons three Bills for the amendment of the Patent-law. The provisions of one of these, that promoted by the Society of Arts, have been fully explained and discussed in this room at previous meetings. One of the others is Mr. Anderson's short annual Bill, a Bill which it is not unfair to consider is meant rather to represent the views of its originators, than put forward with any serious idea of its passing into law. The third Bill is the important measure which was introduced early in the Session by Mr. Chamberlain, and was read a second time on Monday last. The Bill was well received on both sides of the House, and though exception was taken to many details, it was understood that the consideration of these details was to be left until the Bill came before the Standing Committee, to which it was referred immediately after the second reading. There seems every expectation that the Bill, having progessed successfully so far, will, in some form or other, become law during the present Session, and it is therefore extremely important that those who have any objection to urge against any part of it, or any suggestions to make for its improvement, should raise those objections or make those suggestions in time for their consideration before the members of Parliament who form the Standing Committee commence their work. The tone of the able speech in which the Bill was introduced by the President of the Board of Trade, showed that he was seriously anxious to promote a reform of the law, and that he had given full attention to the views which have been put forward in this room both by the Chairman of the Council, Sir William Siemens, and by his immediate predecessor, Sir Frederick Bramwell. I think, therefore, that there is every reason to believe that he will be ready to listen to the opinions which may be expressed in the discussion of this evening, and that the Society of Arts, whose work has already been so well appreciated, may render yet further service to the Government in the difficult task of introducing a new patent system. The views of the Council, as represented by their Patent-law Committee, are set forth with sufficient clearness in the Society's Bill, and they have been ably put before the House of Commons by one of the members

of the committee, Sir John Lubbock. The Council, however, felt that it would be well for individual members of the Society to have an opportunity of stating their views upon a measure of such importance, and it was to afford such an opportunity that they adopted a suggestion made by the Patent-law Committee, that the paper which I am now about to read to you should be brought forward this evening.

Now, in considering a measure like the present, it may be stated at the outset, that nothing but a thoroughly satisfactory Bill ought, for one moment, to be accepted. Those who have had the task of framing it have had the experience of thirty years' working of the present system, a system which, with all its imperfections, has stood the test of those thirty years extremely well, and will bear comparison with that existing in any other country in the world; they have had before them the reports of three Parliamentary Committees and a Royal Commission; they have had the advantage of considering the many Bills which have been, from time, to time introduced for the amendment of the law, notably the excellent Bill introduced, in 1879, by the then Attorney-General, the late Sir John Holker; and last, but certainly not least, the Bill promoted by the Council of this Society. With all this information — all this accumulated experience — available, there can be no excuse for the introduction of an imperfect or ill-considered measure. It would, of course, be hopeless to expect that any Act could possibly be passed which would satisfy the conflicting claims, or reconcile the divergent opinions put forward by different persons, on a subject like the law of patents. What may fairly be asked is, that any measure introduced with the authority of the Government, at the present day, should satisfy the legitimate demands of all the different parties so far as is possible, should remedy the admitted defects in the present system, and should be conceived in such a way as to promote the best interests of the country.

Briefly stated, the object of a perfect patent system should be to encourage invention, by holding out sufficient, but not excessive, rewards to those who make useful inventions; to secure to the public the full benefit of inventions, both during the period of protection and afterwards; to stimulate progress in the application of all knowledge to useful purposes, by taking care that information as to what has already been effected is readily accessible; and to do all this in the simplest, clearest, and easiest fashion, at the least cost of time, trouble, and money, to the inventor and to the public.

Unless the present Bill can be shown to do all this—unless it is found to reach the high standard which can legitimately be applied to it—it would be better to let it follow the fate of its numerous predecessors, and to wait yet another year or two for the reform so often asked for, and so long delayed. It is the object of the present paper to try and ascertain how far the present measure will satisfy these legitimate aspirations; or, at all events, to put the matter before you in such a form that a discussion upon the Bill may result likely to inform those members of Parliament who are interested in the matter, and especially those forming the Committee, which has the Bill before it, as to the views of a meeting specially qualified to deal with this complicated question.

For the purposes of discussion, the Bill, or at least that portion of it relating to patents for inventions—for I do not propose to touch, this evening, upon the divisions of the Bill relating to trade-marks and designs—may be conveniently considered under the following heads:—

1. Government and organisation of the office.
2. Applications for, and grant of patents.
3. Amendment of specification.
4. Compulsory licenses.
5. Prolongation and revocation.
6. Legal proceedings.
7. Scope of patent as against Crown, and miscellaneous regulations.

I.—Government and Organisation of the Office.

The Bill abolishes, by repealing the Act of 1852, the offices of Commissioners of Patents, and substitutes for their authority that of a Comptroller under the Board of Trade. In substituting a paid responsible official for the unpaid officers previously at the head of the Patent Office, the Government have complied with the appeals which have been made in successive memorials and petitions presented by the Society, since 1876, to the Houses of Parliament, the Lord Chancellor, and the Home Secretary; while, in transferring the jurisdiction to the Board of Trade, they have acceded to the prayer of the latest of these petitions, the one to the House of Commons, in

December, 1880. They have not adopted the proposal of the Society of Arts' Bill, that three commissioners, each a man of special knowledge, should be appointed; and perhaps, if it could be ensured that the new officer would be a gentleman of such standing and authority as is obviously contemplated in the Society's Bill, there might not be much to complain about, except that the work to be done — if done properly—is more than any single individual could be expected to deal with. Under the Bill, however, the comptroller is not only subject to the Board of Trade, that is to say, to the President of the Board at the time being, and the chief permanent officials, but also in many respects to the law officers, to whom power of appeal is given from most of the comptroller's decisions, while (section 85), if he is in doubt as to the "administration of the provisions of the Act," he is to apply to one of the law officers for directions. It would, therefore, rather appear as if the comptroller, instead of being, as he certainly ought to be, an officer of similar rank at least to the Commissioner of Patents in the United States, is merely to be a superior officer of the Board of Trade. Doubtless, the provisions of the Bill would admit the appointment of such an officer as the former, but there can hardly be any doubt that the appointment contemplated is not of such a character.

II.—Applications for, and Grant of Patents.

This is, of course, the most important part of the Bill—in fact, it may be said that the essence of the Bill is to be found in the clauses comprised under this head. In the first clause relating to this subject we find that any person, whether a British subject or not, may make an application for a patent; and going on, it appears that the applicant must in his application state that he is the true and first inventor. It has been suggested that this would put an end to the existing system of "communications from abroad," and it might possibly do so; but inasmuch as the old definition of the statute of James, "Any manner of new manufacture" is retained as the definition of an invention, and as it has been held that that definition includes importation as well as original invention, there seems no reason why the present practice should not be continued. For a person importing from abroad an invention new within the United Kingdom would, according to the terms of the Act, be really the true and first inventor. Unless this reading of the Act is incorrect, it would certainly be necessary to make a provision that a foreigner applying for a patent might do so through his attorney or agent in England. Such a regulation would be an improvement on the present system, under which a little confusion not infrequently occurs from the patent being connected with the name, not of the actual inventor, but of the agent who took the patent out. In future histories of inventions, the names of Newton, Bousfield, and Brooman will doubtless rank above those of Watt, Stephenson, and Arkwright, in consequence of the enormous multiplicity of the inventions with which those gentlemen are credited in the official list.

Coming to the details of the method of application—and it must be remembered that it is in the seemingly minute details the gist of the whole matter is to be found—in the interests of brevity, it may be assumed that those present are familiar at once with the present system, and with the provisions of the new Bill, and that it will only be necessary to dwell on those points where some considerable novelty is introduced, or on which difference of opinion is likely to arise. Now, the first point which occurs, unless exception be taken to the rule that a provisional specification must, if required, be accompanied by drawings, is certainly the requirement that the provisional specification should end with a distinct statement of the invention claimed. Surely a provision of this sort does away at once with the principal advantages of the whole system of provisional protection. How is an inventor, who by the theory of the case is only expected to give in rather broad outlines the idea which is in his mind, to distinctly state what it is he wishes to claim? He may, indeed, be taken to know what his invention is, and what it will do, but he is very likely to be quite ignorant as to what part of his invention he can legitimately and definitely claim. Of course, the inventor who goes to the Patent-office with his invention fully completed, can state what he wishes to claim, but then he may as well file his complete specification at once and have done with it. If there is any uncertainty in his mind as to the exact way in which his invention is to be worked out, or if, as is often the case, he has not ascertained precisely how much of his invention is new, and in how much of it he has been anticipated, the definite point which he is prepared to claim and stand by is, perhaps, the very last thing of all on which he can make up his mind. I

suppose no patent-agent would undertake to draft the claim at the end of a specification until he had drafted the specification itself complete in all its details. For it is not as if, having made his claim in general terms, he is afterwards to be at liberty to alter it. We find further on that the claim, as originally made, and as inserted in the complete specification is to be the same; having once made up his mind to it, the inventor must either stick to it or lose his patent. Then, again, what is the advantage of inserting a definite claim in a document like the provisional specification? We are told in the memorandum to the Bill that it will be a great help to indexing; but if no better argument can be advanced than that it is to save Patent-office officials a little trouble, or enable a more cheaply paid class of clerks to do work which ought to be discharged by competent officers, this provision may fairly be said to carry its own refutation along with it. The reference of, first, the provisional and afterwards the complete specification to an examiner, has been adopted from the Bill of the Society of Arts, but the principles on which the Society's scheme is based have not been carried to their legitimate conclusion. The examiner is to report whether the invention is subject matter, whether the description is sufficient (in the Bill, as drafted, this part of the examination is confined to the provisional, but it may fairly be assumed that it was a mere oversight not providing for a proper examination of the more important document), and whether the claims in the two specifications are substantially the same. As regards matters to be inquired into, they are not very different in the two Bills, except in the objectionable notion that the claims of the two specifications must be identical; but in the Society of Arts scheme, matters thus inquired into were to be settled once for all, and were not to be brought up against the patentee in any action for infringement. It having once been decided that the inventor had a right to a patent for his invention, and that the documents were properly drawn, no further question on these heads was to be allowed. In the Government Bill, after the examination is made, the inventor himself is no better off than before. In an action for infringement, he may have to fight the whole matter over again, to show that his invention was proper subject-matter for a patent; to answer any objections to the form and matter of his specification; in fact, to carry on his action as he does now. It is true that by the Government examination, the great point will be achieved that the public will be benefited by having a proper description of the invention, while, now and again, as happens under the present law, some so-called inventions would be knocked on the head at once, by being refused a patent at their early stages. These, however, are small gains in comparison with that intended by the Society of Arts' Bill, which would provide the inventor with a guarantee, with regard to those points of his patent which the Government could fairly be required to guarantee, in order to give him something for his money; and, as Sir Frederick Bramwell tersely and strongly put it, in his last paper here, to relieve the Government from the reproach of taking money under false pretences, by accepting fees for the grant of a patent which a court of law might afterwards decide ought never to have been granted at all.

The patent is only to be granted for a single invention, and if these words are not construed in too close and exacting a spirit, there can be no objection to such a provision. It is, however, the opinion of some well qualified to judge, that the rules will be interpreted to mean that only a single claim will be permitted. Sir Edward Reed, answering Sir John Lubbock's objection to this clause in the debate on Monday, said that this was not the intention, but at any rate there is grave doubt whether the Bill does not admit of such a rendering, and the point ought to be made clear. How in the world could anybody, after constructing a complicated machine, state, in a single sentence, what it was he demanded protection for? How is the inventor of a new steam-engine, an improved loom, or any other complicated piece of machinery, to formulate his demands in a single claim? The invention may consist partly in a new adaptation of old parts, partly in the application of new parts; or it may be wholly and entirely new. The thing would be perfectly hopeless, unless, indeed, the inventor is allowed to take refuge in the usual American claim for "the whole invention substantially as described," in which case it would be almost impossible to prove infringement.

Supposing the decision of the comptroller to be adverse on any point, an appeal lies to one of the law officers, the Comptroller being turned into a sort of *advocatus diaboli*, showing cause before the law officer why the patent should not be granted. Now, the main objection to the present system is that it throws a vast

amount of work upon officials whose hands are already full, and the present Bill proposes to select, perhaps, the busiest of those officials, and to give them a great deal more work than they ever have under the present system. As above stated, this appeal to an outside legal authority in itself diminishes the authority and lowers the standing of the comptroller; but, worse than this, these appeals to the law officers, coupled as they are with the reference to them of all cases of opposition, would, it can hardly be doubted, prove utterly unworkable in practice, even though every allowance be made for the fact that, after the first crop of appeals, the Comptroller would endeavour to base his decisions on the result of those appeals, and it would be pretty generally understood that appeals would be useless. This portion of the Bill might, therefore, become harmless, because nugatory, in itself not a desirable consummation, and certainly one which can hardly be put forward as a recommendation by its authors. It is not stated that an application is to be advertised, and it may be that no notice of applications is to be published prior to the notice of their acceptance. If this system was worked so as to ensure the non-publication of provisional specifications, there would be a good deal to be said in favour of the plan, but at all events, whatever the intentions of the Government may be, they ought to be clearly stated. There is not, perhaps, much more to be objected to in the arrangements for application, except that power is given to the law officer, when the matter comes before him, to make conditions under which his award is to be accepted. Supposing his award to be a proper one, it is not easy to see why it should be subject to any conditions.

We now come to the case of opposition. Notice of opposition may be given by anybody, the only limitation being that he must be, in the opinion of the law officer, entitled to be heard. It is not said what is to guide the law officer in forming such an opinion. The vicious part of the rules for opposition is, that notice can only be given after the complete specification becomes open to public inspection, a plan which would take away the main safeguard of the honest inventor, whether the patentee or opponent, and open the door to knaves.

In such cases at present, the case of the person opposing is, generally, simply that the invention is his; and the proof that it is his lies merely in the fact that he can describe it. When the information is open to all the world, it is hard to see what simple proof a man can give that he has a better right to the thing thus publicly described than the person applying for the patent; at all events, this system of opposition upon open documents would mean that oppositions, instead of being, as now, rapidly decided by the law officer and a couple of patent agents, would, in all probability, assume the proportions of a trial at law, with counsel, witnesses, and all the other costly paraphernalia. The inventor would, in fact, be involved in a lawsuit at the very outset, and he would find that, in spite of reduced fees, the process of obtaining a patent was far more expensive, in very many cases, than under the present system.

Again, consider the unsatisfactory position of an applicant who is refused protection after he has filed his complete specification, and thus made public all his knowledge. He is deprived of the opportunity even of working his invention in secret, and put in a much worse position than if he had never made any application at all. Even if his patent was properly refused, there might be much valuable information in his specification, and of the exclusive use of this he would be unjustly deprived. Then how great is the temptation to rivals in trade to attempt opposition, especially in cases when it might be known that the applicant was not wealthy enough to encounter the cost of meeting it. These are only some of the considerations which make one wonder at the introduction of such provisions as exist in the Government Bill. Many of the other objections to the proposal are well and clearly stated in a paper read four years ago in this room, by Mr. Lloyd Wise, upon the 1879 Bill, in which Bill it was proposed to allow opposition after the publication of the final specification.

In the Society of Arts' Bill, opposition was only to be allowed in cases of fraud, and these indeed are the only cases in which it should be permitted. There would then be little objection to allowing it after the publication of the specification, and there would of course be certain obvious advantages, especially if it could be provided that the opponent should be compelled to give notice, and to put in his own description, before seeing the specification of the person applying for the patent.

Having thus endeavoured to point out the objections to the proposed system for granting patents it is only fair to direct attention to the advantages it offers. The whole procedure is

very greatly simplified; the number of forms is less; applicants may, if they like, transact their business by post, and thus avoid either personal attendance or the payment of fees to an agent. It has been said that this provision makes the Bill one for the abolition of patent agents, but if this apprehension really exists in the breasts of any of the members of that profession, it surely is a most groundless one. If the man who is his own lawyer has a fool for his client, equally well may the same be said of the inventor who is simple enough not to avail himself of the advantage of professional advice, supposing he can afford it. On the other hand, it is certainly a great privilege for an inventor, who cannot afford such fees, to have the opportunity of doing the best he can for himself at an economical rate.

The extension of provisional protection from six months to twelve is a distinct gain to the inventor, who will now really have time after his first application, in the one case to work out his invention, or in the other case, if a poor man, to try and dispose of it advantageously. It appears also that there would be, under the new rules, no temptation to the mischievous practice of "racing for the seal;" that is to say, trying to cut out a previous applicant by getting an application of later date sealed before his, though this is not quite certain. The limitation of the fees in the earlier stages will be accepted as a great boon by the advocates of cheap patents, though signs are not wanting that considerable pressure will be put upon the House to make large if not corresponding reductions in the charges for the later stages. The plan, adopted from the Society of Arts Bill, and from the 1879 Bill, of making a patentee take out a certificate of renewal, instead of requiring him to produce his original Letters Patent, is a useful provision, and so are the clauses, taken from the same sources, which provide for the enlargement of time in cases where, by accident or otherwise, the patentee fails to take out the certificate of renewal at the proper date. The omission of any clause corresponding to that in the 1852 Act, which limits the term of a British patent to that of any corresponding foreign patent, is most important. The existing rule is extremely objectionable, and will, perhaps, hardly find a defender. It is difficult to know whether to class the regulation that the patent is not to have effect in any of the Channel Islands until it has been registered there as an advantage or a disadvantage; because probably few not connected with those important dependencies of the British Crown, have the faintest idea of what the rule means.

III.—Amendment of Specification.

With regard to this important point, the Government have evidently been considerably influenced by the Society's Bill, but the provisions they propose are very much less liberal than those of either the Society's Bill or Sir John Holker's 1879 Bill. The wording of the first clause dealing with this subject gives rise to the opinion that an application for amendment may only be made once, especially as the words "from time to time," which appear in the corresponding clause in the Society of Arts Bill have been left out, and the wording of this clause of the 1879 Bill adopted It is, of course, well known to those who have experience in such matters, that there may be just as great a necessity for a second, or even a third, amendment as for the first. In the recent well-known case of the Edison Telephone patent, the specification was amended no less than three times. If, as is most probable, it is the intention of the framers of the Bill that successive amendments should be permitted, it is desirable that this should be distinctly stated in the Bill. Here, again, too, we meet with the provision entitling the law officer to lay down conditions, an arbitrary power which, as before mentioned, certainly should not be granted to any official. But the most important clause of this part of the Bill is the one stating that "no amendment shall be allowed which would make the specification as amended claim an invention substantially larger than, or substantially different from" the invention as originally claimed. This clause appears intended to confine the power of amendment merely to verbal alterations, such as are now made, and would not permit any redefinition, any claiming of matters originally included, but not distinctly claimed, any explanation which practical working of an invention may show to be necessary or desirable. Amendment of the specification in this direction is surely most desirable, not only to permit but to encourage, alike in the interest of the inventor and of the public. The Society of Arts' Bill would allow any amendment which would not make the specification comprise any invention which could not have been originally claimed in it, while the 1879 Bill, in addition to clauses similar to to those above mentioned, contained provisions for amendment by way of supplement.

A valuable clause has been introduced, allowing a patentee to disclaim any portion of his specification during the progress of a patent case, though this would certainly be less effective than the provision in the Society's Bill not allowing the defendant to plead the invalidity of any part of the patent not alleged to be infringed.

IV.—Compulsory Licenses.

The clauses relating to this subject are practically identical with those of the 1879 Bill, most of which were adopted in the Bill of the Society of Arts. The whole question of compulsory licenses is one which has been much debated, and it may, perhaps, be said that the suggested provisions would meet the views of those who advocate such licenses, without pressing unduly hard upon the proprietors of patent rights. It is, perhaps, worth noting that though the Board of Trade may "order the patentee to grant licenses," the framers of the Bill do not appear to have contemplated the possibility of a patentee declining to obey the Board's command, for they have prescribed no penalty for such disobedience.

V.—Prolongation and Revocation.

The existing system for the prolongation—or, as it is termed by the Bill, extension of term—of a patent, is practically the same as now, that is to say, it is left to the Privy Council. The enormous and unnecessary cost of the present system is surely a sufficient reason why the process should be changed. In the Society of Arts' Bill this matter, like other patent business, was left to the Commissioners of Patents; and here, again, comes in the advantage of having a strong commission, to whose decision questions like this might be left. If the Comptroller is to be merely a subordinate official of the Board of Trade, he might not be considered competent to decide questions of so important a nature: and here we have one more argument for improving his position and his official rank, so that he may be considered capable of dealing with any matter that could be referred to him. As for revocation, the obsolete process of *scire facias* is repealed, and instead of it there is substituted a process which, to the lay mind, seems very similar. The distinctive feature of the proceedings by *scire facias* was, that the defendant was entitled to begin, and this particular provision is inserted in the Bill.

VI.—Legal Proceedings.

This is a part of the Bill upon which a person who is not a lawyer cannot wisely say very much. It may be noted that the proposal made in the Society's Bill to direct the court, at the request of either party, to an action, to call in a qualified assessor, has been adopted.

VII.—Scope of Patent as against Crown and Miscellaneous Provisions.

Some of the miscellaneous provisions have already been dealt with in previous parts of this paper. Perhaps the most important amongst the others is the incorporation in the Bill of the 1859 Act, by which patents for warlike inventions might be assigned to the Secretary of State for War, and certain provisions made for the keeping secret of the invention. The importance of this clause lies in the proof it affords that the framers of the Bill would not approve any provision similar to that inserted in the 1879 Bill, and adopted by the Society, that a patent should bind the Crown, subject to provision for the Naval and Military Services. There is, therefore, no improvement on the present condition of things, and the natural result will be to discourage inventions dealing with any branches of industry in which the Crown does, or may hereafter, exercise a monopoly. The most obvious instance of this is given by the relation of the Post-office to inventors of telegraph apparatus. It is stated, and apparently with good reason, that the existing monopoly of the Crown is having a very bad effect upon this class of inventions in England as compared with other nations, notably with America, which is more liberal in this respect. Supposing that at some future time the Government were to buy up the railways, as has often been proposed, it is easy to see how serious an effect upon another most important branch of invention the absence of any restraint upon the power of the Crown over patented inventions might have.

The general rules now made by the Commissioners for regulating the business of the Patent Office, the issue of the various official publications, and similar matters, would be made by the Board of Trade. Under the existing law such regulations are to be laid on the table of the House, and are therefore liable, at least in theory, to revision or alteration. This slight safeguard is abolished by the present Bill.

The control of the existing Patent-office Museum is to be transferred to the Science and Art Department, which department is to have power to require a patentee to furnish a model of his invention on payment of the cost.

A provision likely to be very useful instructs the Comptroller to issue periodically an illustrated journal of inventions, reports of patent cases, and other information.

The penalties to be inflicted on persons making unauthorised use of the Royal Arms will doubtless cause a diminution in this class of crime, but the rule may, perhaps, press unduly hard on many honest folk who have been unwittingly labelling their wares with the forbidden decoration.

I have now endeavoured to bring before you what are, I believe, the principal points in the Bill to which attention should be drawn, with a view of obtaining amendment. There are, indeed, other points upon which much might have been said, such for instance as the question of fees and the length of term; these two questions, however, have already been so fully discussed, that it can hardly be possible to say much that is new about them; and with regard to other omissions, I can only say that I have designedly made this paper somewhat short, as it is intended to start, not to exhaust, discussion. If I have devoted the main portion of my space to the enumeration of defects, I may remind you that the object of a paper like this is to draw attention to faults, with a view to their removal. Gratitude for favours received must be assumed, even if it be not expressed. On the whole, I think it cannot be doubted that the Government Bill is defective in many important respects, and requires careful amendment in Committee. The machinery is inadequate, many parts of it would prove unworkable, and some others, it can hardly be doubted, would not work in the way which it may be assumed was intended by its framers. It is, however, certain that Mr. Chamberlain, and those with whom he has acted, are anxious to do the best they can to improve the law, and there need not, I think, be much fear but that they will listen to any suggestions for the improvement of their measure, and will give those suggestions such attention as they may think they deserve.

I cannot conclude without expressing my personal indebtedness to the members of the Society's Patent-law Committee, and especially to two of them, Sir Frederick Bramwell and Mr. Alfred Carpmael. I have no right, nor would it be proper for me, to put myself forward as the exponent of the views of the Committee; but I do not think there are any points of importance in this paper with which the Committee would not in general concur. More than this, I have had the great advantage of the assistance and advice of the two gentlemen I have mentioned in the preparation of this paper, and, indeed, I can honestly say I think it owes whatever merit it may possess, chiefly to the assistance so kindly given me by them.

DISCUSSION.

The CHAIRMAN, after expressing his desire to do all in his power to promote full and due protection to inventors, as being of the utmost importance to the country, said he could not but recognise that this Bill was a great gain to the inventive mind of the country, and whatever might be its defects, it would be a lamentable thing if the year went by without its being passed. It was very gratifying to see that the discussion whether patents were desirable at all, seemed to have entirely subsided, and the only question now remaining was, as to the best system of Patent-law to be adopted. He should have, in many points, to compare the provisions of the Society of Arts' Bill with that now brought forward by the Government, not for the purpose of suggesting that the Society should endeavour simply to force its views on Parliament, but because he thought a careful examination of the two would show that the framers of the Society's Bill had studied the subject more carefully, and had thought out their views more thoroughly than those who had framed the Government Bill. He did not say there were no points in which the Government Bill was to be preferred, but in the most important and difficult matters, the Society's Bill was, in his judgment, undoubtedly superior. From some practical knowledge of the working of the present system, he should say that the abolition of the Commissioners of Patents as a body, and the substitution of one Comptroller, would be practically unworkable. If the Comptroller had simply to perform the duties now supposed to be performed by the three Commissioners, it would be a work which no man ought to undertake; but in addition to that, he would have many other duties, such as appearing before the law officers when a patent was objected to, so that, on the whole, it would be impossible for any man, however skilled, to perform all the duties required, including as they did, the control of patents, designs, and trade-marks. He had no objection to the appointment of a director-general of the Patent-office, who would, no doubt, find plenty of work to do in the management of the office; but it was almost absurd to suppose that the work which the Society's Bill proposed to leave to a competent body of commissioners, could be properly performed by any one

single Comptroller. With regard to the "true and first inventor," he would not attempt to lay down what the law was, but he thought it at least desirable that the true and first inventor should be defined. He did not question Mr. Wood's idea, that the law was probably intended to remain as at present; but if importers were intended to be protected, and to be deemed inventors, the Bill had better say so. This was not merely a verbal criticism; it would be easy to deal with the question how an agent for a foreign inventor should proceed; the question was what should be the position of the mere importer of an invention, and the position of a foreigner who had taken out letters patent in a foreign country. On this point there was room for great difference of opinion; personally, he was of opinion that it would be better that the simple importer should not be deemed to be the inventor, unless he were the original inventor in the foreign country, though he knew there were many who held a different opinion; but at any rate he thought a suggestion which he had seen ought to be adopted, viz., that an importer should not defeat the right of the original inventor if the latter came for protection within a limited time. This was quite beside the question of what should be adopted with regard to a *bonâ-fide* foreign inventor seeking a patent in England. The next question of importance was that of the claim at the end of the provisional specification. He agreed with Mr. Wood that this was a most undesirable clause, and when the clauses of the Bill were examined, he thought it would prove quite unworkable. By Section 9 the claim in the complete specification was to be the same as that in the provisional; by Section 31 a patent was only to be granted for one invention; and by Section 19 the inventor might disclaim any part of his invention. He did not know what would be the position of a patent agent having a provisional specification brought to him, and asked to frame a claim before he had the information the complete specification was supposed to give, and told he must only claim one invention, and further, that if the patentee came to disclaim, he must only disclaim a part of one invention. Members of Parliament, who had to deal with this matter, ought to have their attention directed to what was the real evil to be met, and a straightforward way of dealing with it pointed out to them. The Society's Bill practically hit the nail on the head when it suggested that a patentee should not be allowed by any amendment to claim anything which could not be claimed under the original patent. He saw no necessity for having a claim in the provisional specification at all; there ought to be a full and proper description of the invention, and the examiners ought not to allow anything to be claimed ultimately which was not covered by the description; but the proper time to make the claim was when by the preparation of the complete specification the invention was perfected, and the working of it understood. Clause 31 said there should only be a patent for one invention; but who could say, from a provisional specification, whether a particular thing was to be properly described as one invention or two? Take the common case of improvements in a loom or spinning-frame, which were really the sequence of one line of thought, but each of which might possibly be patented as a distinct invention — it would be impossible at first to say whether it was one invention or more. If it were considered objectionable to have more than one invention in a single patent, he would suggest a simple remedy, namely, that, when the complete specification was sent in, the examiner or commissioners might have power to direct, if they thought fit, that two or more patents should be granted, and the matter should proceed on that footing, without invalidating what had already been done. He thought the examination as to subject-matter and sufficient description was satisfactory; but he should like to see a clause inserted that, when once an invention had been passed as being subject-matter, it should not be liable to attack on that ground. That would not prevent the question of novelty being raised, and if a patent were really old, there was no difficulty in upsetting it on that ground. The real substantial protection to the public would be afforded by being able to show that the invention was not new; but it was only fair to a patentee that, so far as a definition of what was subject-matter was concerned, he ought to be told when he applied for his grant whether what his specification showed was subject-matter or not. With regard to oppositions, he could not but think that Section 11 had got in *per incuriam*, for he could not imagine anything more remarkable than that opposition should only be allowed after the complete specification had been made known to the public. It would open the door to fraud by the worst class of persons, those who were not inventors, but were sufficiently clever to adapt some crude experiments to the description contained in the specification. Unless the grounds of opposition were limited, in order to be both effective and fair, it must be before the complete specification was filed. It would work great injustice to the patentee to allow general opposition, and at the same time give the opposing party full information of what the invention was. Then arose the question whether it was desirable to limit the grounds of opposition. The Society's Bill proposed to limit it to the case of a person from whom the patent had been obtained, or the representatives of such; he was not prepared to go so far as that, but a suggestion he had seen was well worthy of consideration, that if the grant of letters patent were opposed on the ground that the opponent had previously discovered the invention, he ought to be called upon, before he saw the complete specification, to file a description of his own invention. At present, the opponent's case was put by his counsel, but he ought to be made to describe it in his own language; and then it could be compared by the examiner with the invention opposed, in a way which would be fair to all parties. He would

add that if opposition were allowed, there certainly ought to be power to examine witnesses. As regards prolongations, he did not approve of the present tribunal for granting prolongations, but as only a very small per-centage ever applied for them, it was not a matter of great importance, still he would throw out the suggestion that the term should be 17 years in all cases, and prolongations be abolished. If they were retained, however, and there were competent commissioners, it would be better that applications should be made to them than to the Privy Council. With regard to legal proceedings, he confessed that he preferred the Government Bill to that of the Society, and thought giving power to call in specially qualified assessors, when desired, was the best way of meeting the difficulty. It was said, in the course of the debate in the House, that nothing more was required; that assessors were not wanted, or, if they were, they could be obtained; but, with all deference to the eminent gentleman who made that statement, he ventured to differ from him. He thought in many cases assessors would control the length of the examination of witnesses, would indicate that certain points were immaterial; they would be a check on witnesses who were desirous of going further than they ought, and they would also be a check on counsel. Again, he did not think that at present an assessors could be obtained if either side chose to demand a jury. It was suggested in the Society's Bill that a defendant should not be allowed to set up a plea of want of novelty as to a part of an invention which he had not infringed, and, in principle, he agreed with that suggestion; but he thought that was not the best way of meeting the difficulty. If there were an absolutely bad patent, it would be unwise in the public interest that the patentee should succeed in any action; and the difficulty seemed to him to be met by the provision that a patentee might, even in the course of an action, disclaim any part of his specification. He could thus, if so advised, disclaim a part alleged not to be new, and still maintain his action for infringement of that which was new. He entirely agreed with the criticisms on Clause 41, with regard to warlike implements and things of that kind, and hoped an effort would be made to make patents binding on the Crown; he would not discuss the question whether or not they were so now, but he could not see why the Government should take the benefit of any man's brains without paying for it. Another point of interest was whether any attempt should be made to limit the time within which prior publication should invalidate a patent; the Society's Bill proposed a limit of thirty years, and he thought such a provision a very good one, so that a patentee might get his rights even if he re-discovered an old invention which had been forgotten. One matter which was not mentioned, either in this Bill or that of the Society's, was the point on which he expressed a strong opinion last year, and which he still adhered to, though it had been somewhat criticised, viz., that the simple publication of a provisional specification of an invention not put into practice, or carried further, should not invalidate subsequent letters patent. He had gone carefully into the matter, and believed there was scarcely a case in which a patent otherwise good had been invalidated on this ground, though it was often one of several elements in proving want of novelty. He protested against the suggested destruction of provisional specifications, as it would obliterate what might add to the common knowledge, and he saw no harm in allowing a man to take up a provisional specification which had fallen through, carrying forward the invention to success, and obtaining a patent for it. Such a case would not often happen, and when it did, both the patentee and the public would benefit by it. In conclusion, he would say that this was a great and important measure, promoted not in the interests of any party, but of the whole community, and of the poor inventor. The cheapening of patents was, in itself, a thing worth fighting for; it was the thin end of the wedge, and might lead to further progress in the same direction. The Bill had been introduced by the Government in the best spirit, in language which showed an appreciation of the efforts of those who had worked on the subject before; whatever faults it had were faults of detail, which might be amended, and he trusted that all who discussed it would do so with the one object, of endeavouring to make it as perfect as possible.

Mr. CLEMENT HIGGINS thought their duty was not only to criticise the weak portions of the Bill, but also, and quite as emphatically, to express approbation of those parts with which they agreed. It was very pleasant to find that the Bill, in the main, fulfilled the promises held out by Mr. Chamberlain a year ago, when he said he intended to increase the facilities and lessen the cost of obtaining patents. With regard to one or two minor points, such as the tribunal for trying patent actions, he would congratulate the Society on having withdrawn that portion of their Bill which provided that such actions should be tried before commissioners. As the law now stands, either party might insist on a jury, and under the provisions of the present Bill, either party might claim the right to call in assessors; but how assessors and a jury would work together he did not know. He would suggest that there should be a discretion to a Judge at Chambers to decide whether the action should be tried by a Judge and jury, by a Judge alone, or by a Judge and assessors. With regard to the revocation of patents, he believed you could not proceed by *scire facias* without the *fiat* of the Attorney-General, and practically such a thing was never heard of; but, as he understood, under this Bill, an action for revocation could be brought by any one at any moment, and if this were so, he could not help thinking that there would be a kind of trade in revocations by rival manufacturers, or others whose interests were affected by patents, which

would lead to a great deal of litigation, and would not be at all to the public interest. He agreed with what had been said as to the claims in the provisional specification, and did not see why a patent should not be given for more than one invention. He thought the best plan would be to let a patent be granted, as at present, for as many inventions as a man liked to include in it; but if one invention only were infringed, the infringer ought not to be allowed to attack the patent on the ground that another invention included therein was not new. Very little had been said on the question of fees, but that was the main point in the Bill, and for which it ought to be supported. Property must be taxed, but the tax should be imposed upon the rewards of an invention, and not upon the invention itself. It was the product, not the seed, which ought to pay, and that seemed to be the principle adopted.

Mr. LLOYD WISE did not agree with the provision that the Patent-office should decide what was subject-matter, though this had been approved by the Chairman. Even under the existing law, patents were refused that ought to be granted. He had recently had a case before him in which the application was refused on the ground that the invention was not a fit subject for a grant of letters patent, no explanation whatever being given. The invention was for a combination of parts with mechanical action; it involved a manufacture, and the article produced would be one of utility, and he was, therefore, quite at a loss to know why protection was refused; especially as at present the law-officer was not supposed to go into this question. It was not pretended there was no invention, nor that the nature of the invention was insufficiently described in the provisional specification. The only conceivable ground of objection it would seem must be some unpressed doubt as to the novelty or importance of the invention. The law said that, if satisfied the provisional specification described the nature of the invention, the law-officer should allow provisional protection. If, notwithstanding this fact, patents were even now refused on such grounds as he had mentioned, what might they expect under the new Bill? He did not see, himself, how the question of subject-matter could be considered apart from the attribute of novelty; it was a most difficult matter to deal with, and he strenuously objected to that portion of the examination clauses of the Bill. He felt convinced the very serious consequences likely to result in practice had not been realised. Moreover, qualified examiners were not available, special training and great experience being needful for the proposed work. There were several other points on which he should have been glad to offer a few observations, but he refrained from doing so, regard being had to the lateness of the hour, and the presence of many others who, doubtless, wished to speak.

Mr. BARKER objected to drawings being required with the provisional specification, as it would add greatly to the expense, and thus be an obstacle in the way of poor inventors.

Mr. HAUGHTON wished to draw attention to an omission in the present and all previous patent Bills, viz., there was no protection for an inventor who had his invention stolen from him, and patented by another man. He ought at least to be restored to his original position; but though such a fraud would vitiate the patent obtained by the thief, the mere fact of the patent being granted, and the consequent publication, prevented the original inventor obtaining any benefit from it. The Bill did a great deal of good in cheapening the preliminary steps, and also in making licenses compulsory; but for this last provision he should not agree with the criticisms passed on the clause giving the Government the right to use inventions. He would remark also that novelty was only one ingredient in the subject-matter.

Mr. BOLAS thought the proposal to regard a provisional specification as not equivalent to publication would lead to serious difficulties in practice. There would be people always on the look-out for such specifications which were not proceeded with, rewording the claim, and applying for a fresh patent.

Mr. REDDIE said there was one important point in Mr. Wood's paper which had not been commented on, viz., that the racing for the seal would in all probability be done away with; but there was nothing to prevent a second applicant hurrying forward his complete specification, and getting his letters patent first. As a matter of fact, the Crown did constantly grant more than one patent for the same invention.

The CHAIRMAN remarked that Section 13 provided that every patent should be dated and sealed as of the date of application.

Mr. REDDIE said that only applied where the patent was granted. As regards subject-matter, he thought there was every reason why some control should be exercised. He had recently seen a glaring case in the American official *Gazette*, of an invention which he was perfectly certain was old and well-known in England. Old inventions might be raked up and patented, and great confusion would arise if it were admitted that when once a patent was granted you could not attack it on that ground. If the suggestion were adopted for limiting the period of prior publication to 30 years, there would be a race to the Patent-office, and a number of applications would be made for old inventions dished up as new ones, and great difficulties might arise with regard to prior user. An invention which had been described more than 30 years ago might be considered obsolete; but in some remote districts it might be going on doing good work in a quiet way, and it would be very hard to come down on those who were using it as infringers.

Mr. CORNELIUS WALFORD was glad to hear from the majority of the speakers the impression that the present Bill would very much simplify the law of

patents; for he feared it was still very far from perfect in that respect. What was really wanted was to encourage and assist the ingenious inventor, and in order to do that, the law ought to be as simple and plain as possible. Those who had any influence with the Government, or members of Parliament, should aim not at introducing new complications, but at simplification. He had had opportunities of knowing the working of the American law, and though it was by no means perfect, there were many points in it which might be usefully followed.

Admiral SELWYN said the first objection he had to the present system had been ably met by Mr. Chamberlain's peroration in introducing the Bill, but not at all by the Bill itself. He said the inventor was a creator of trade, and the Bill was drawn on the principle that he deserved encouragement, not repression, and this not in the interest of the inventor himself but of the State. He had great hopes of what would result from the adoption of this principle, which was a complete change of front. The unwisdom of putting one man to do nine men's work was sufficiently obvious, and he thought it most desirable that whoever was appointed commissioner should have had judicial training, and still more that he should not be alone, but that some one should be able to take up his work either when he was unwell or overworked, which would almost certainly be the case. He would advocate the appointment of three persons of judicial experience, at salaries not inferior to the importance of the subject; and he would have their duties entirely distinct from the examination of trade-marks or designs. The next thing was a competent staff of examiners; they might be made very useful or utterly useless according to the duties entrusted to them. They might be called upon to examine incomplete documents which revealed nothing, or to keep the inventor in the straight path, and to prevent him, by wise advice, from doing that which they knew, and he could not know, existed in the office already. The inventor would be very glad of such assistance, and would be able to go back to his patent agent—who would be in no way superseded—prepared to advise with him far more efficiently. With regard to the provisional document, it was absurd to require that it should be substantially the same as the complete one. The old legislation recognised that a man required provisional protection while he was perfecting his invention, because a new machine of any kind did not spring into being all at once, like Minerva, fully armed from the brain of Jove; it had to be worked out carefully. The property created by Patent-laws required to be protected more carefully than most people recognised, because capital would not be attracted to an invention unless there was absolute security, and if this were not accomplished, you only gave a man simulated protection. There were two sides to the question of charging small fees first and heavy ones after. You might induce the man to give you his invention by the small fee, and if he could not pay the larger ones when they were demanded, you seized on his invention. If this were found to be the case, the country would suffer, because inventors would go elsewhere. He was opposed to compulsory licenses; such things were only expedients, not legislation on principle. If a good lawyer could drive a coach and four through any Act of Parliament, a patent agent and an inventor together would drive through any compulsory license. He agreed with the suggestion as to the thirty years' limit of prior publication, for most great inventions had been made before their time. One question raised was whether it would not pay the State to have old inventions taken out of the gutter and re-patented. The manufacturer would probably say, "No, let it remain there until it suits me to use it;" but that was not the view of the State. It was for the benefit of the State that every invention that could be used should be made use of. The clause as to the use of inventions by the Government was unfair to the inventor. If he did not get a fair return for his labour, he would either cease to invent, or might be tempted to accept offers from foreign Governments. The one thing he had always contended for was that, although in the view of some persons inventors were sheep to be shorn in the interests of the State, they were sheep to be protected; and if once Mr. Chamberlain had embraced this idea, and would carry it out, we should have so mamy inventions, that it would be no longer a question of paying £20 or £30 in fees, but of the increased income-tax which would accrue from the results. Could the income to the State, from such a patent as Bessemer's, be measured by the fees paid? How many thousands were gaining a living from the one invention. It was nonsense to say there was more inventive power in America than there was in England; the great difference was, that there was more encouragement to the inventor.

The discussion was then adjourned to Tuesday evening, the 24th, at 8 o'clock.

Miscellaneous.

ECONOMIC BOTANY AT KEW.

The Annual Reports on the Royal Gardens, Kew, contain an epitome of work done in the development of the uses, and the introduction of new economic plants, by attention to which the vegetable resources of the world are doubled or trebled, and the perpetuation of important food or medical plants ensured, so that supplies of indispensable articles are guaranteed to future ages. A few abstracts from the report for 1881, which has recently been issued, will give an idea of the nature of the work in this direction.

Cocoa Plants for Eastern Colonies.—In the Kew report for 1880 (pp. 13, 14), the steps were recorded which had been taken to transmit from Trinidad, through Kew, to Ceylon, Singapore, and Fiji, plants of the best known cultivated varieties of the cocoa plant. The seven Wardian cases despatched from Kew in the autumn of 1879 reached Ceylon in good order. Out of 182 plants sent, 127 were alive, 24 in a doubtful state, and 31 dead on their arrival at Peradeniya, November 5, 1880; none of the 11 varieties sent wholly failed. The plants for Singapore were despatched from Ceylon, March 9, 1881. The Hon. Cecil C. Smith wrote, August 25, respecting them :—"They are doing fairly well now, but it took some little time to recover the effects of their removal. The cultivation of cocao is becoming important here, and in our neighbourhood it promises to be a decided success. The same, too, as to coffee. The accounts from Johore plantation, and from Sunghy Ujong (next to Malacca) are very satisfactory, and it was only last night that I was told that in the latter place cinchona is doing admirably. Unfortunately we cannot, nor can our planters, get the *Ledgeriana*, but we will make a further attempt to induce the Dutch authorities to give us some." The plants for Fiji were despatched from Ceylon in April, and reached their destination in the following July. Unfortunately, they had all perished in transit. In the same year, however, Mr. Prestoe despatched from Trinidad a supplementary case containing the plants required to make up the full number of twenty of each variety, which he had been requested to procure. These reached Kew in good condition, and were immediately forwarded to Ceylon. Out of thirty plants, twenty-seven arrived in October living, while three were dead, or nearly so. Dr. Trimen retained nine of the plants, and despatched the remaining eighteen to Fiji, which they reached on December 23. Mr. Thurston, the Colonial Secretary, reports as follows :—" With the exception of two plants, the contents of the case on landing at Suva appeared all that could be desired, and, the weather being warm and moist, the others were at once planted out in the ground prepared for them. Since planting, the cacao plants, as well as several cuttings of the *Erythrina umbrosa* (Madre del Cacao), which accompanied them, have budded freely, and appear in a fair way to establish themselves rapidly. While writing this letter, I have received a note from a planter, to whom I gave a few plants of cacao (Java), less than three years ago, to the effect that it is bearing, one tree having over twenty pods upon it, and an immense quantity of blossom." The plants which reached Fiji ultimately, fortunately, represented no less than seven distinct varieties, including *Criollo* (red and yellow), *Cundeamar*, *Forastero* (red), *Sangre toro* (yellow), and *Verdilico*.

Cow Tree.—The Palo de Vaca, or Cow-tree of South America (*Brosimum Galactodendron*), grows in large forests in the mountains near Cumana, and in other parts of the sea coast of Venezuela. It forms a tree frequently over 100 feet high, and often running to a height of 60 or 70 feet before branching. The milk, which is obtained by making incisions in the trunk, is said to have an agreeable taste like sweet cream with a slightly balsamic odour; it is somewhat glutinous, but said to be nourishing and perfectly wholesome. According to Boussingault, the constitution of the "milk" of the Cow-tree approaches very closely that of the genuine milk of the cow. At the request of the India-office, we obtained from Venezuela a supply of the seeds (through the kind assistance of Dr. Ernst, Professor of Natural History in the University of Caraccas). A case of germinating seeds was duly despatched in October, 1880, to the Superintendent of the Victoria-gardens, Bombay. No information has since reached Kew, officially, as to the result of the experiment. I extract, however, the following account from Mr. Stormont's report on the Khandish Government Farm, for 1881 :—" Six small healthy-looking plants of the Cow-tree (*Brosimum Galactodendron*) were received from the Superintendent of the Victoria-gardens, Bombay, in July; of these, two were sent for trial in Dhulia, three others planted out in ordinary garden soil, and one merely shifted into a larger pot. The latter is doing well; but those planted out have made no progress, have even lost most of the leaves they had. What they may do in the hot weather remains to be seen." The home of the Cow-tree in Venezuela is in 10° N. lat., and in a doubtless very damp climate. How it will fare 11° further north, with a rainfall of under 40 inches, is a not perhaps very hopeful prospect. A portion of the seeds retained at Kew germinated, and plants were sent during the past year to the botanic gardens of the following places :—Adelaide, Brisbane, Calcutta, Ceylon, Fiji, Java, and Singapore. In Ceylon, the plants are reported as doing well, though slow in their growth.

India-rubbers.—*Castilloa*, *Ceylon.*—Dr. Trimen reports :—The *Castilloa*, both at Peradeniya and Heneratgoda, produced flowers during the dry weather of April; on examination, however, these were all male. This species is said not to produce seed till eight years old. The finest tree at Heneratgoda has now a stem of 22½ inches in circumference at about a yard from the ground.

Madras.—Mr. Cross writes, March 6, 1881 :—" *Castilloa elastica*, of which there are only three plants, has evidently found a home on the banks of the Nilambur River. . . . A *Castilloa* tree, if carefully and judiciously tapped, with a diameter of 1½ to 2 feet, may be expected to yield about twelve pounds of rubber per annum. Of all the different species of rubber-producing trees, the *Castilloa* should prove, under cultivation, the most remunerative."

Ceara.—*Ceylon.*—Dr. Trimen reports :—" *Ceara* continues to interest planters by its rapid growth, ready propagation, tenacity of life, and early production of seed. From this latter quality chiefly it has resulted that the loud and urgent

demand for seed has almost ceased in Ceylon in the course of one year. We have distributed it to several planters in India, and to the Government establishments there; some also to Singapore for a further trial, as well as to Jamaica and other colonies. . . . During the early part of the year, I made a preliminary and tentative investigation to ascertain the condition of the milk in our *Ceara* trees at Peradeniya, and the best means of obtaining it. The principal conclusion I arrived at was that the trees had not their milk in a sufficiently concentrated state to invite tapping. I was quickly led to the opinion that the method of preparing the stem, as practised by the natives in Brazil (according to Mr. Cross), would not be found either convenient or economical. The milk vessels occur in two layers; the richer one is in the innermost stratum of the bark, just outside the cambium; but there is a smaller one immediately beneath the thin green layer; this latter is sacrificed by the slicing process, which also causes loss from the milk adhering to the shavings. In the culture of this kind of rubber, the principal difficulty will, I think, be the extraction of the milk. It appears to be present in good quantity, but a very small amount flows from each cut, and it is difficult to avoid drip and loss if the stems are not perpendicular. It is not possible, at present, to make any estimate of the slightest value as to the probable average yield of a tree. The plant is evidently very hardy, and rapidly recovers from bark injury. I think I should repeat here what I said two years ago, that the yield of a few trees cannot be remunerative, and only large plantations can hope to repay the cost of collection. The quality of the dry rubber (resulting from milk laboriously obtained from one tree by small incisions) appears identical with the Ceara scrap of commerce, in spite of the extremely watery character of the milk. Further experiments will shortly be made."

Madras.—The india-rubber trees at Nilambur have been planted in an open space of teak forest land, on the bank of the Nilambur river. "The plants," writes Mr. Cross, March 6th, 1881, "have, in the brief space of two years, shot up in the most surprising manner, the highest upwards of thirty feet in height, and are how yielding an abundant crop of seeds. I was shown one strong rank sapling, which, in five months from the time of planting, had grown up, and produced flowers. This region is, without doubt, admirably adapted for the growth of the tree. At the same time I would confine the general planting of the Ceara rubber to rather dry arid situations and poor soils. . . . . Mr. Ferguson was desirous of proof of the actual existence of rubber in his Ceara saplings, and although these were too young to yield this product, I resolved to make an attempt to satisfy him. The natives at Ceara, in bleeding this sort, simply slice off the outer portion of the bark on one side of the tree, from the base, to a height of four or five feet. The milk exudes from pared portions of the trunk, and runs down in little courses. By the following morning the milk of these courses is sufficiently solidified to be pulled from the trees in strings, which are rolled up into balls as the work of collection proceeds. When this process was tried on one tree, the milk exuded freely; but next day, on examination, it was found that the greater portion had evaporated, showing the watery and immature state in which the milk exists in young growing plants. However, in making incisions on the collar and largest roots of the plants, milk of good quality was obtained, which next day was found coagulated. From the collars of five saplings about an ounce of rubber was obtained, which, in appearance, elasticity, and odour, could not have been distinguished from Ceara scrap, as seen in commerce. But it is manifest that the trees ought to be allowed to attain some size before being wrought." Mr. Jamieson reports from Ootacamund, October 25, 1880:—"Ceara rubber is going to be a decided success at Barliyár; the largest tree has now attained a height of seventeen feet, having made a growth of fourteen feet in twelve months. After several unsuccessful attempts to propagate this plant from cuttings, I have succeeded in rooting three plants, which which will be grown in the hothouse in the Ootacamund Gardens as stock plants, as I have found that the young tender shoots, grown under glass, propagate more readily than cuttings from trees grown in the open. The largest tree flowered at Barliyár, in May last, and I hope to get a quantity of seed from it for distribution. I sent five healthy Ceara rubber plants to the Agri-Horticultural Society's Gardens, Madras, and they arrived in good order."

Mauritius.—Mr. Horne writes, October 3, 1881:—"*Manihot Glaziovii* grows remarkably well here, and we propagate it by cuttings when it is leafless. These strike like willows in the open ground, but they must not be disturbed until the next season, when they are at rest, as otherwise the cut rootlets bleed the plant to death. From letters in some of the papers, the writers do not seem to be aware of this, or they would not wait for their trees seeding to increase their stock of them."

(To be continued.)

Correspondence.

TRADE ROUTES OF PERSIA.

I had intended to offer a few remarks on some portions of the interesting paper and discussion concerning the trade routes of Persia, on Tuesday, 3rd inst., but was deterred by the lateness of the hour. These I now beg to submit in the shape of a letter, and in doing so should, perhaps, say that I have only recently returned to England, *viâ* the Caspian, Volga,

and Russia, after a residence of nearly eight years in Persia, and that I know every inch of the road from Enzelli, on the Caspian, to Bushire, on the Persian Gulf.

The exports of Persia are unfortunately of less value than the imports. This is shown by the great and increasing demand for bills, which in my time has sent the exchange up from 25 krans to the £ to 27 and more. No doubt part of this rise is due to the fact that the kran was debased some years ago by the farmer of the mint, who, having bid too highly, could only recoup himself, and make his 50 or 100 per cent. profit into the bargain, by resorting to this device.

The opium trade, which at one time promised well, has lately received a shock from which it may never rally. In their thirst for gain, the Persian merchants (or some of them) took to preparing the balls, not only with treacle and oil, but with large-sized pebbles dexterously centred within. Of course, John Chinaman, who, I believe, was the chief, if not only customer, soon detected the fraud, and now the Persian opium is, in more senses than one, a drug on the market. In the year 1881-82, some heavy failures occurred in consequence, in Bushire, Shiraz, and Ispahan to my knowledge.

Colonel Champain has described the road from Bushire to Shiraz as execrably bad, and he has not used too strong a term, a worse road does not, I believe, exist in the world.

Of the six passes mentioned by Colonel Champain, two (the third and sixth, starting from Bushire) are not formidable; one, the third, can be avoided by going through a gorge, connecting the plains of Khisht and Kazeroon. This gorge runs parallel to the present road (over the low shoulder of hill), and was actually used ten years ago by caravans quite as often as the upper road. It was then forsaken on account of the many robberies that had been perpetrated there. The other, or sixth pass, could, if necessary, be turned by bearing to the left after passing the village of Dasht-i-Arjin, and striking, across low hills, the upper course of the Kara-gatch river; but this detour would hardly be necessary, as the present road over the Sineh-Safeed could, under a better Government, be made quite easy.

The first, second, and third passes could possibly be avoided by leaving the beaten track at Daliki altogether, and following up the left bank of the Khisht river. Emerging on the Kazeroon plain, and still following up the stream, which is here called the Shapoor river, we enter the gorge or valley of Shapoor, so famous for its statue, caves, and sculptures. Going on to the end of this gorge we find an opening to the right, which takes us without great difficulty into the Oak valley, thus avoiding No. 4 pass, or the Kotal Dukhter. Traversing the Oak valley, and crossing obliquely the present road, the fifth, and worst pass of all, could be turned by striking the mountain a couple of miles farther east of the present road, where the range dips very considerably. My friend, Captain Wells, thinks, and I agree with him, that, if not in the days of Alexander, certainly in those when Shapoor was king, *circa* 250 A.D., the high road, instead of going up the Kazeroon plain, and over the Kotal Dukhter and Pir-i-zan (fourth and fifth passes), as now, led up the Shapoor valley, through the Oak valley, and across the low saddle of the Pir-i-zan range, into the plain of Dasht-i-arjin. I believe we may soon expect some very interesting information on this part of the road from Captain Wells, with an account of the celebrated caves which I had the pleasure of exploring with him two years ago.

Before leaving this part of the subject, I must mention that there is another road to Shiraz, which, judging from the number of very old ruins, marking the sites of large cities, must have anciently been used. I allude to what is known as the Firozebad road, which, though much longer than the present, is so easy (comparatively), that wheeled traffic is possible. The rest of the road, from Shiraz to Ispahan, and from Ispahan to the capital, offers no difficulties.

Gray, Dawes, and Co. is not the only English house trading in Persia. Messrs. Ziegler and Co., of Manchester, have branches, with European managers, at Teheran, Resht, Tabreez, Sultanabad (near Hamadan), and Ispahan; and at Yezd, Shiraz, and Bushire, with native or Armenian agents. Besides these, there is Holtz and Son, a Dutch house, with European agents, at Bushire, Shiraz, and Ispahan; and at Yezd and Teheran, with native or Armenian agents. All these establishments are doing, if not a roaring trade, at least a fairly remunerative business; and it is a significant fact that two of the three firms that I have just mentioned have occupied the ground (Shiraz and Ispahan) from which Gray, Dawes, and Co. retired. The house of Muir and Co. is of recent date at Bushire—a fact which, I think, points rather to an increase in trade than otherwise. Large quantities of bar iron, sheet copper, and candles are *still* imported by way of Bushire; so, I am afraid, my friend Mr. Mackenzie has been misinformed on these points.

At this moment, besides the chartered steamers mentioned by my friend, there are very commodious vessels, owned by an Anglo-Indo-Persian company, and another company, whose head-quarters are at Marseilles.

Mr. Martin Wood alluded to the French project of opening up the Karoon, which was promoted by Dr. Tholozan, the Shah's physician, but he is mistaken in supposing that our neighbours are any more favoured in this instance than we are. The French scheme came, long ago, to nothing, and mainly, as I suspect, owing to the opposition of the French legation at Teheran. Besides, the French scheme contemplated irrigation, not navigation.

As to the suggestion of re-afforesting, I do not suppose that Persia ever enjoyed a greater rainfall than it receives in our days.

Persian trade wants no factitious aid; only remove the impediments placed in its way by a but half-civilised Government, and it must prosper. Russian diplomacy has done, and is doing, this in the North; it is for England to do the same in the South.

J. J. Fahie.

PORTRUSH ELECTRIC TRAMWAY.

Referring to the discussion on the economy of the Portrush Electric Tramway, which took place after the reading of Mr. A. Siemens's and Dr. E. Hopkinson's paper, on Wednesday, it appears to me that an important element was neglected, which is necessary to the comparison between steam and electricity.

Without entering upon exact figures, it may be taken that a passenger train on an ordinary branch railway would weigh as follows:—

Engine	45 tons.
First-class carriage	9 ,,
Second-class ,,	9 ,,
Third-class ,,	9 ,,
Van	10 ,,
Say 60 passengers	4 ,,
Total	86 tons.

= about 26 cwt. per passenger.

On a tramway the engine would weigh seven tons, and carriages to hold 20 passengers inside and 20 outside would weigh about two tons:—

Engine	7 tons.
2 carriages	4 ,,
60 passengers	4 ,,
Total	15 tons.

= 5 cwt. per passenger.

On the electric line no engine would be attached to the train, the carriages, however, would be somewhat heavier, say:—

Two carriages	7 tons.
Sixty passengers	4 ,,
Total	9 tons.

= 3 cwt. per passenger.

* Branch railway..29 cwt. of train per passenger.
Steam tramway.. 5 ,, ,, ,,
Electric ,, .. 3 ,, ,, ,,

Let the final calculation of economy be based upon the work done in the shape of paying load, and assume that the indicated horse-power of the locomotive on the tramway and of the stationary engine driving the dynamo, be nearly equal; electricity could then afford to waste or lose in transmission 40 per cent., and still be even with the tramway locomotive.

* The train weights, without passengers, being respectively 82, 11, and 5 tons, with seats for about a similar number; a calculation omitting the weight of the travellers makes the contrast even more glaring.

If this comparison be made with a railway, then 80 per cent., or even 90 per cent. of current might be lost on the way, and yet the stationary engine producing it would have no more horse-power to exert per passenger drawn than the locomotive on a branch railway.

Henry Barcroft.

The Glen, Newry, April 16, 1813.

General Notes.

Council.—Two members of the Council of the Society of Arts have just received the honour of Knighthood, viz., the Chairman — Sir William Siemens, F.R.S., and Sir Frederick A. Abel, C.B., F.R.S., Chemist to the War Department.

Government Patent Bill.—The Right Hon. Joseph Chamberlain, President of the Board of Trade, moved the second reading of his Patent Bill, in the House of Commons, on Monday, April 16. After a discussion in which Sir John Lubbock, Mr. Gregory, Mr. Broadhurst, Mr. Jackson, Mr. C. Davey, Mr. Wills, Mr. Carbutt, Mr. Stuart Wortley, Mr. Samuelson, and Sir E. Reed joined, the Bill was referred to the Standing Committee on Trade.

MEETINGS OF THE SOCIETY.

Extra Meeting.

Tuesday evening at Eight o'clock:—

April 24.—Adjourned Discussion on Mr. H. Trueman Wood's paper, "The Government Patent Bill." Richard E. Webster, Q.C., will preside.

Wednesday evenings at Eight o'clock:—

April 25.—"Economy of Sanitation." By Capt. Douglas Galton, C.B., F.R.S. Robert Rawlinson, C.B., will preside.

May 2.—"Electricity as a Motive Power." By Prof. George Forbes.

May 9.—"English and Foreign Silver Work; with Some Remarks on Hall-markings." By Wilfred Cripps, F.S.A. Sir Philip Cunliffe-Owen, K.C.M.G., C.B., C.I.E., will preside.

*** The reading of Mr. Seymour Haden's paper, on "The Relative Claims of Etching and Engraving to rank as Fine Arts," previously announced for May 2, has been postponed until May 30th, when Sir Rutherford Alcock, D.C.L., will preside.

Applied Chemistry and Physics Section.

Thursday evenings at Eight o'clock:—

April 26.—"A New Process for the Separation and Recovery of the Volatile Constituents of Coal."

By T. B. LIGHTFOOT, M.Inst.C.E. Sir H. HUSSEY VIVIAN, Bart., M.P., will preside.

MAY 24.—"The Development of Electric Lighting." By J. E. H. GORDON, B.A.

INDIAN SECTION.

Friday evenings at Eight o'clock :—

APRIL 20.—"The Fisheries of India." By Surgeon-General FRANCIS DAY. ANDREW CASSELS, Member of Council, will preside.

MAY 25.—"Some Notes on the Domestic Architecture of India." By C. PURDON CLARKE.

CANTOR LECTURES.

Monday evenings at Eight o'clock :—

Fourth Course, on "The Transmission of Energy." By OSBORNE REYNOLDS, M.A., F.R.S., Professor of Engineering at Owens College, Manchester.

LECTURE I.—APRIL 23.

General considerations relating to the transmission of energy; the transmission of energy requires power; the means by which, and the distances through which energy is transmitted in nature; the distribution of energy on the earth, and the means of concentrating and distributing it.

LECTURE II.—APRIL 30.

The storage of, and conveyance of stored energy in forms available for power; the limited capacity of all reservoirs of energy; the limits to the possible distance through which power may be transmitted by mechanical means.

LECTURE III.—MAY 7.

The transmission of energy through pipes and conductors; summary of economic considerations relating to the transmission of energy.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Osborne Reynolds, "The Transmission of Energy." (Lecture I.)

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m.

British Architects, 9, Conduit-street, W., 8 p.m. Mr. Alex. Beazeley, "Notes on Domestic Dwellings in Southern Sweden."

Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Prof. W. Fream, "Farm Crops; their Habits and Requirements."

Medical, 11, Chandos-street, W., 8½ p.m.

Antiquaries, Burlington-house, W., 2 p.m. Annual Meeting.

TUESDAY, APRIL 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Adjourned Discussion on Mr. H. Trueman Wood's paper, "The Government Patent Bill."

Royal Institution, Albemarle-street, W., 3 p.m. Professor J. G. McKendrick, "Physiological Discovery." (Lecture IV.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on Mr. P. O'Meara's paper, "The Introduction of Irrigation into New Countries, as illustrated in North Eastern Colorado." 2. Mr. John Mackensie, "Resistance on Railway Curves as an Element of Danger."

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. W. M. Flinders Petrie, "The Mechanical Methods of the Egyptians." 2. Mr. F. C. J. Spurrell, "Some Palæolithic Knapping Tools, and Modes of using them."

Science Society, King's College, Strand, W.C., 8 p.m., Mr. J. M. Thomson, "The Artificial Imitation of Vital Processes."

WEDNESDAY, APRIL 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Captain Douglas Galton, "The Economy of Sanitation."

Geological, Burlington-house, W., 8 p.m. 1. Prof. R. Owen, "The Skull of the *Megalosaurus*." 2. Mr. H. W. Monckton, "Notes on the Bagshot Sands." 3. Prof. T. G. Bonney, "Additional Note on Boulders of Hornblende Picrite near the Western Coast of Anglesey."

Royal Society of Literature, 4, St. Martin's-place, W.C., 4½ p.m. Annual Meeting.

THURSDAY, APRIL 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Mr. T. B. Lightfoot, "A New Process for the Separation and Recovery of the Volatile Constituents of Coal."

Royal, Burlington-house, W., 4½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. W. H. Cope, "History of Stained Glass in England during the Middle Ages."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. Waldstein, "Art of Pheidias." (Lecture IV.)

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Society of Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Discussion on—1. Mr. John Munro's paper, "Some New Forms of Telephone Transmitters, with a Note on the Action of the Microphone." 2. Messrs. I. Probert and Alfred W. Soward's paper, "The Influence of Surface-condensed Gas upon the Action of the Microphone." 3. Mr. Shelford Bidwell's paper, "On Microphonic Contacts."

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. W. C. Street, "The Drainage and Water Supply of Small Towns."

FRIDAY, APRIL 27...Royal United Service Institution, Whitehall-yard, 3 p.m. Captain R. H. Harris, "Maritime Power, and its Probable Employment in War."

Royal Institution, Albemarle-street, W., 8 p.m. Sir William Siemens, "Solar Physics."

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, APRIL 28...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Sir John Conroy, "A New Photometer." 2. Mr. H. R. Droop, "Colour Sensations." 3. Mr. Walter R. Browne, "Causes and Consequences of Glacier Motion." 4. Captain Abney, "Measurement of Radiant Energy."

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor Geikie, "Geographical Evolution." (Lecture IV.)

Journal of the Society of Arts.

No. 1,588. Vol. XXXII.

FRIDAY, APRIL 27, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The first lecture of the fourth course, on "The Transmission of Energy," was delivered by Professor Osborne Reynolds, M.A., F.R.S., on Monday evening, 23rd inst. The lecturer drew attention to the general considerations relating to the transmission of energy; the means by which, and the distance through which, energy is transmitted in nature; and he concluded with some remarks on its distribution on the earth, and the means of concentrating and distributing it.

The lectures will be printed in the *Journal* during the autumn recess.

Proceedings of the Society.

NINETEENTH ORDINARY MEETING.

Wednesday, April 25th, 1883; Robert Rawlinson, C.B., in the chair.

The following candidates were proposed for election as members of the Society:—

Kinsey, William Barns, Michwood Church-lane, Merton, Surrey, and 33, The Exchange, Southwark-street, S.E.

Martin, John May, Castle-chambers, and Bradninch-house, Exeter.

Scott, Mrs., 3, Harrington-mansions, Queen's-gate, South Kensington, S.W.

Smith, Reuben, Moulton Grammar-school, Spalding, Lincolnshire.

Sudeley, Lord, 7, Buckingham-palace-gate, S.W.

Whitwill, Mark, J.P., Redland-house, Bristol.

The following candidates were balloted for and duly elected members of the Society:—

Ough, Henry, 16, Austin-friars, E.C.

Porter, Captain Henry Richard, R.A., 32, Belgrave-road, S.W.

Roebuck, Rev. Alfred, Rookfield-avenue, Sale, near Manchester.

Selous, Edric, M.D., 133, Adelaide-road, South Hampstead, N.W.

Tate, A. Norman, 9, Hackins Hey, Liverpool.

The paper read was—

ECONOMY IN SANITATION.

By Captain Douglas Galton, C.B., D.C.L., F.R.S.

The history of sanitation furnishes numerous examples of a waste of money, and of injury to health, caused by defective sanitary works constructed upon wrong principles; and it has been observed that the total number of lives which might have been saved by sanitation has been largely diminished by premature deaths caused by a misapplication of sanitary principles, or a defective execution of works. The term economy in sanitation, includes the application of sound principles to sanitary works; the method of executing such works economically and efficiently; the saving of labour and expense in the removal of refuse which results from such works; and the saving of life, and increase of productive power in the nation which results from diminished death-rates and sickness. The chief points, however, to which I propose to direct attention this evening are the following:—

First, how the sanitary works in our houses, which are necessary adjuncts to the diminution of preventible disease, can be effected economically.

Secondly, the saving to the community which arises from the diminution from preventible disease.

Thirdly, the influence of uniformity of administration on sanitary progress.

I. Economy in House Sanitation.

An enormous expenditure has been incurred in this country during the last 40 years in endeavouring to diminish preventible disease. This money has been mainly spent upon sewerage, water supply, and improvement of streets, upon an increased staff for looking after the healthiness of the towns, for seeing to the removal of refuse (scavenging), for inspection of houses, and removing insanitary dwellings.

The expenditure has been incurred by the various local authorities, with more or less system according to circumstances. But there has been probably as large an expenditure, of which no record can be kept, which has been made inside houses by the owners or occupiers, without system, and, in many cases, it is to be feared, wastefully.

When the drainage of houses and sewerage began to be substituted for cesspits, the plans first adopted were to cover the beds of streams or ditches, so as to convert them into sewers, and to require the adjoining houses to connect with them; but the way in which the connection was to be made was very much left to the owner or occupier. The evils of this system, by the bad effects produced, became gradually more and more apparent, and a reconstruction of the sewers upon the principle of being self-cleansing became recognised as imperative.

Much preventible disease, however, may arise in places where, although street sewers have been carefully made, defects occur in the house drains. And it is only within recent years that it has become generally admitted that in safeguarding the health of the public, it is as necessary that the method of connection between the house-drains and the sewer, as well as the construction of the house-drains themselves, should be made a part of the drainage system of a town, just as the main sewers themselves are.

The further we proceed in our knowledge of sanitation, the more evident does it become that, in the matter of drainage especially, it is to the details, as much as, if not more than, to general principles, that we must look, as if the details are faulty in house-drains, the perfection of street sewers will not always avail to prevent disease. It has therefore become manifest that the duty of local authorities ought not to stop at the construction of the street sewers.

In a community, living in a closely packed congregation of dwellings, the health of any one person, and the sanitary condition of any one dwelling, must necessarily be matters of the highest importance to the community. For it has been abundantly proved that some of the most formidable forms of disease will fix upon insanitary dwellings, and, having formed a citadel there, will extend their operations all around.

Each step that we take in sanitary improvement in our towns shows that good sanitary arrangements all hang together, therefore that it is the interest of the community that each dwelling should have good sanitary appliances.

The occupier of a house may know little of drainage, and he may call in a builder, who knows less; and the result is a wasteful expenditure, and possibly the aggravation of evils which it was desired to remedy, and these evils affect the health of the occupier of the house, and may, through him, become a source of danger to the community.

In order to guard against these dangers, certain associations have recently been formed for inspecting the drains in private houses, advising the householder on their condition, and informing him how the defects can be remedied. These associations are managed by some of the leading sanitary authorities of the country. They are based upon the principle of being self-supporting, but they also bear, to some extent, a philanthropic character. These associations give expression to a generally felt want, viz., that qualified experts should be available, to inspect and advise on house-drains; and that experienced workmen should be at hand to remedy defects in a systematic manner. But if it be admitted, as is certainly the case, that house-drains are a part of the drainage system of a town, it follows that the inspection, and the systematic remedy of defects in house-drains, should be carried on under the officers of the local authorities; it also follows that these sanitary officers should be thoroughly qualified, by education, for their posts. Medical men are not allowed to practise their profession until they have passed the necessary examination; and we have now arrived at a point in sanitary progress where the surveyor and inspector of nuisances, appointed by local authorities, should be similarly required to undergo a special training in order to qualify them for their appointments.

For the reasons above mentioned, and in order to ensure that the work may be done systematically, well, and economically, it follows that local authorities should not stop at the function of inspection, but that they should recognise that a complete system of house drainage is the necessary complement to a system of town sewerage; and they should assume the function of inspecting and reconstructing house-drains at the expense of the owner or occupier. The work would be done much more economically than it can now be done, because it would be done in each district under one supervision, and under a general contract.

The advantages of consolidation for the purpose of obtaining economy are apparent. The supervision would be concentrated, and thus an increase of valuable service would be obtained with a diminution of expense. The works would be executed upon a uniform system, and under general contracts; the greater part of the work being nearly uniform in character, would enable both the contractor and his workmen to become experienced in the details, and thus the work would be done better, cheaper, and more systematically. In this way the consolidation of the management of house-drains in the hands of the local authorities would be economical to the householder, and at the same time more effectual for checking disease.

II. Saving Arising from Diminution of Preventible Disease.

The facts which establish the loss to the community, which arises from preventible disease, cannot be too often brought forward, or urged upon the public. The amount of preventible disease occasions a continued waste of the force and energy of the nation. It leads to misery, and thence to the spread of vice.

Dr. Richardson has described to us, in that graphic language of which he is so consummate a master, a model city of Hygeia, from which preventible disease would be banished, and where deaths would be rare. He has shown us that the age to which man from his natural conformation could aspire, would be at least 100 years; and that if we could extirpate preventible and hereditary disease, we might all live to, and many exceed, this allotted age. But, unfortunately, we are as yet far from having obtained cities constructed on the model of Hygeia; and the habitations occupied by a large portion of our population, as well as the conditions under which the people live, promote the spread of preventible disease, and tend to intensify rather than to diminish hereditary disease. Whilst we who now live may despair of seeing our cities made equal to Hygeia, or of profiting by an extension of the age of man to the limits described by Dr. Richardson, I think that we may reasonably hope that the standard of health, which now prevails in the healthy districts of the country, may be extended to other parts of the population.

One of the objects of my paper to-night is to endeavour to show that the efforts which we have made to improve the health of the people are beginning to bear fruit; and to draw your attention to the money value of sanitation; and I trust, in conclusion, to make clear to you that it is of the greatest importance to push forward with energy the methods of sanitation which have been devised by experience, because these methods, besides promoting the physical health and increasing the wealth of the nation, also tend to advance the social and moral condition of the people.

(a.) Results of Sanitation on Death-rate.—I have seen it alleged that, notwithstanding the immense expenditure which has been incurred for sanitary improvements, the death-rate of the United Kingdom has not diminished, and that the duration of life has not been increased. Even if this were so, we must remember that sanitary improvement has done much, if it has prevented an increase in the rate of mortality, in consequence of the increased density of population.

In the supplement to the 35th Annual Report of the Registrar-General (dealing with the mortality in the ten years, 1861-70), Dr. Farr pointed out that there was a very distinct relation betwen density of population and mortality, the mortality increasing with density, not, however, in direct poportion, but the mortality was found to be generally about as the 12th root of the density.

I would take this opportunity of alluding to the great loss which sanitary science has experienced from the death of Dr. Farr. The value of sanitation can only be made apparent with the aid of the statistician. Dr. Farr has done more than any one else in this country, or indeed in Europe, to advance this branch of the science of sanitation.

The Table on p. 578 exhibits the influence of density on health according to Dr. Farr's calculations in his report.

By this Table it will be seen that of 593 registration districts into which England (exclusive of London) was divided during the 10 years 1861-70, 53 had rates of mortality ranging from 15 to 17 per 1,000 persons living; the average density in these 53 districts was 166 persons to a square mile; the average birth and death-rates were respectively 30·22 and 16·75 per 1,000 persons living, and the mortality, calculated from the density in the several groups, was 18·90 per 1,000. Now, the mean density of population in England and Wales in the ten years, 1841-50, was 289 persons to a square mile; while, in the ten years, 1871-80, it had increased to 415 persons to a square mile. In the first-named decenniad,

THE REGISTRATION DISTRICTS OF ENGLAND AND WALES, GROUPED ACCORDING TO MORTALITY (EXCLUSIVE OF LONDON).

Mean annual rates of mortality per 1,000 persons living, 1861-70.	Number of registration districts at the rates of mortality in col. 1	Density. Persons to a sq. mile, 1861-71.	Average annual rates per 1,000 living, 1861-70.		
			Births.	Deaths.	Deaths. Calculated from density.
15-39	593	315	35·11	22·00	20·41
15-17	53	166	30·22	16·75	18·90
18-20	345	186	32·19	19·16	19·16
21-23	137	379	35·78	21·88	20·87
24-26	47	1,718	38·75	24·90	25·02
27-30	9	4,499	40·16	28·08	28·08
32	1 (Manchester district.)	12,357	37·33	32·49	37·70
39	1 (Liverpool district.)	65,823	37·57	38·62	38·74

the average annual mortality to 1,000 population was 22·4, and this would have increased, according to Dr. Farr's hypothesis, in the following ratio :—

$$(289)^{0\cdot11998} : (415)^{0\cdot11998} :: 22\cdot4 : x$$

$$= 22\cdot4 \left(\frac{415}{289}\right)^{0\cdot11998} = 23\cdot4$$

That is, the mortality would have increased solely on account of increased density, with its attendant evils, supposing hygienic conditions to have otherwise remained the same, from 22·4 to 23·4 per 1,000 population.

But the actual mortality in the ten years, 1871-80, was no more than 21·4, in spite of increased density; it would appear, therefore, that the improvement in sanitary administration and in the habits of the people may fairly take the credit of a reduction in the mortality of about 2 per 1,000 population, taking increased density into account. And this represents an annual saving of about 48,000 lives in the last decenniad. If we take the five years, 1841-45, and thus exclude the cholera years, 1848 and 1849, and compare them with the five years, 1876-80, the average death-rate of the former period was 21·4 per 1,000; according to the increase by the law of density it would have amounted in the quinquennial period 1876-80, to 22·3. It was actually 20·8 for the last five years; so that even this less favourable assumption shows an annual saving of 36,000 lives in the past five years. Again, if we take the mean age at death of persons dying in England and Wales during the two decades, 1841-50 and 1871-80, we find the following results :—

Decades.	Mean age of all who died.		Mean age of all who died at ages 20 and upwards.	
	Males.	Females.	Males.	Females.
1841-50	28·4	31·0	55·2	55·6
1871-80	29·6	32·1	56·0	57·3
Per-centage of addition to mean age in 30 years...	4·2	3·5	1·4	3·1

It will be seen from the above Table that, during thirty years — reckoning from the middle of the two decades—the mean age at death, calculated from the dying alone without reference to the numbers living, has increased for both sexes and for those who died at all ages, as well as for those who died above 20 years of age. Thus the mean age at death of the dying at all ages rose from 28·4 in the first period to 29·6 in the second period, the increase being equivalent to 4·2 per cent. The increase in the mean age of males dying above 20 was, however, only 1·4 per cent.

I believe that the fact that we have attained this improvement must be attributed to the enormous expenditure which has been made in sanitary matters, and this is confirmed by considering the records of individual towns.

In the metropolis, the density of population has increased since 1841 from twenty-five persons to an acre on the average, up to forty-nine persons to an acre in 1880.

The mortality in the decennial period 1841-50 was 24·8 per 1,000. According to the increase from the law of density it would have been 26·2 per 1,000 in the decennial period 1871-80. But the mortality was actually 23·7 per 1,000 in 1851-60, and 24·4 in the decennial period 1861-70, whilst in the decennial period 1871 to 1880, it was only 22·5 per 1,000.

The great works for the drainage of the metropolis were commenced in 1859, and may be considered to have been completed by the termination of the decennial period 1861-70; and the diminished death-rate of the last ten years may fairly be attributed to the improved sanitary condition of the metropolis, arising from these works.

In Glasgow, great efforts have been made to improve the water supply, and the dwellings of the poorer classes. Until the last ten years

there is no continuous ten years in the history of Glasgow which would not give a death-rate of 30 per 1,000. The death-rate during the last decade was as follows:—1871-75, 30·29 per 1,000; 1876-80, 25·89 per 1,000; and it was 24 per 1,000 in 1882.

The following Table shows the mortality from all causes, and from the principal zymotic diseases in the chief towns of England, during the ten years 1871-80:—

Cities and Boroughs, and the Metropolis.	Mean annual mortality per 1,000 population, 1871-80.	
	From all Causes.	From the Principal Zymotic Diseases.*
Manchester	29·6	5·11
Liverpool†	28·5	5·93
Salford	28·0	6·19
Oldham	26·3	4·43
Newcastle-on-Tyne	26·3	4·73
Leeds	25·8	4·79
Sheffield	25·6	5·37
Bradford	25·2	4·14
Sunderland	25·0	5·63
Leicester	24·9	5·05
Wolverhampton	24·5	4·34
Birmingham	24·1	5·01
Hull	24·0	4·44
Norwich	23·4	3·96
Nottingham	23·1	3·61
Bristol	23·0	3·22
London	22·5	3·82
Plymouth	22·5	4·09
Brighton	20·4	2·53
Portsmouth	20·0	3·67

* Under this term are included the following diseases:—Small-pox, measles, scarlet fever, diphtheria, whooping-cough, fever (typhus, enteric, and simple continued fevers), and diarrhœa.

† The area embraced in the City of Liverpool is more extensive than that comprised in the registration district for which figures are given in other Tables.

In Dover the mortality per 1,000 was 17·5 for the nine years 1873-81, and 15·8 for 1881.

Thus, whilst we talk of an average death-rate of 20·8 per 1,000 for the whole country, the further we search into the causes of the individual deaths which make up the details, the greater becomes our certainty that, within limits, the death-rate of a community can be increased or diminished by the conduct of that community; and that the law of the increase of the death-rate, owing to the density of the population, is dependent upon the conditions in which the people live. The following Table shows very clearly how, in spite of an increased density of population, and a density which has increased more in the urban than in the rural districts, a greater reduction in the death-rate has taken place in the urban than in the rural districts:—

Mortality in Urban and Rural Districts of England and Wales in the Successive Decenniads, 1851–80.

Decenniads.	Mean Density. Persons to a square mile.	Average Annual Death-rates per 1,000 Living.		
		Urban Districts.	Rural Districts.	Rural Rate below Urban Rate.
				Per cent.
1851-60 ...	325	24·7	19·9	19·4
1861-70	365	24·8	19·7	20·6
1871-80	415	23·1	19·0	17·7

Thus, in the rural districts, whilst the death-rate has only been reduced from 19·9 per 1,000, in the decade 1851-60, to 19 in the decade 1871-80, in the urban districts the death-rate has been reduced from 24·7 to 23·1.

The same fact is illustrated by the Table on p. 580, showing the relative mortality, 1861-70, at each of twelve ages in eight groups of districts of England and Wales, the deaths at each age in the 53 healthy districts being represented by 100.

This Table is constructed from the figures of the census of 1870, as the later figures are not available.

It will be observed that London, with a density of population of 25,761 per square mile, is more healthy than other districts containing only 1,718, 4,479, and 12,357 per square mile.

In connection with this, it is interesting to study the following Table, which shows the deaths from several causes to a million deaths from all causes, under sanitary conditions of different degrees:—

Causes of Death.	Healthy Districts.	England and Wales.	Liverpool Registration Listricts.
Zymotic—			
Small-pox	2,359	6,521	8,141
Measles	6,912	12,865	26,973
Scarlet fever	21,403	30,021	38,302
Diphtheria	10,292	4,945	4,416
Whooping-cough	10,234	15,161	34,021
Typhus, enteric, and simple continued fever	28,146	38,107	76,563
Diarrhœa, dysentery and cholera	23,461	40,521	77,935
Total zymotic	102,807	148,141	266,351
Phthisis	108,481	114,417	96,676
Diseases of the lungs	129,618	149,585	190,066
	340,906	412,143	553,093
Violent deaths	31,181	33,531	47,193

Mortality range	15-17	18-20	21-23	24	24-26	27-30	32	29
Persons to 1 square mile.	166	186	379	25,671	1,718	4,499	12,357	68,823

Ages.	Persons living.	Deaths out of persons as given in column 2.							
		In 53 Healthy Districts.	In 345 Districts.	In 137 Districts.	In London	In 47 Districts.	In 9 Districts.	In Manchester District.	In Liverpool District.
All Ages.	5,903	100	113	129	144	146	165	194	228
0.....	2,646	100	126	167	216	217	251	296	369
5.....	18,116	100	110	140	165	166	189	231	286
10.....	27,624	100	111	131	115	141	140	170	177
15.....	17,825	100	108	123	97	127	142	150	152
20.....	13,210	100	109	118	95	116	124	140	167
25.....	11,990	100	109	120	118	120	141	166	225
35.....	10,050	100	104	121	151	132	162	214	272
45.....	7,874	100	104	123	174	146	184	240	318
55.....	4,425	100	105	125	171	154	177	244	284
65.....	1,902	100	102	118	143	138	155	193	204
75.....	775	100	102	110	122	124	132	148	139
85 and upwards	361	100	110	112	111	116	115	123	99

The Table may be read thus :—Out of 2,646 children living, under five years of age, 100 die annually in the healthy districts ; 126 in 345 districts having rates of mortality of 18 to 20 per 1,000 ; 296 in Manchester district ; and 369 in Liverpool district.

NOTE.—The dying from the several causes in the Table (p. 579) were deduced from the mortality during the 10 years 1861–70, in 51 of the healthiest districts, and the healthy districts life table ; from the mortality in the same period in Liverpool ; and from the mortality in England and Wales in the 20 years 1851–70, and the English life-table.

From this Table (p. 579) it appears that out of 1,000,000 deaths, excluding violent deaths, in an unhealthy district, 221,187 died from diseases which are termed preventible, who would have survived in a healthy district. That is to say, if we could introduce into our towns generally the mortality of the healthy districts, we should diminish our death-rate and sickness-rate by nearly one-fifth.

The Table on p. 581 is also designed to show how seriously the condition of a community is affected by its sanitary character.

Thus, out of 1,000,000 persons born in the healthy districts of England, there would be nearly 800,000 alive at the expiration of ten years, more than three-fourths would be living at the expiration of twenty years ; and at the expiration of fifty-five years, there would still be 534,081 living ; whereas in the Liverpool Registration District, which is selected by Dr. Farr as a standard of an unhealthy district, more than one-half would be dead before the expiration of ten years, and at the age of fifty-five only 184,221 would be still alive.

As the Liverpool Registration District was selected by Dr. Farr as a specimen of an unhealthy district, I append a comparison between this district and three rural districts in Lancashire, from which it is seen how large a saving of life could be obtained if the conditions of health prevailing in those adjacent rural districts could be introduced into the Liverpool district.

DENSITY OF POPULATION AND MORTALITY IN LIVERPOOL AND IN THREE RURAL DISTRICTS, 1871-80.

	Registration Districts.			
	Liverpool*	Garstang.	Limesdale.	Glendale.
Area in acres	2,470	61,115	75,734	147,816
Mean population, 1871-81	224,286	12,281	7,055	11,561
Deaths, 1871-81	75,291	2,192	1,266	1,704
Density—Persons to a square mile, 1871-81 ...	58,115	129	60	50
Average annual mortality per 1,000 population, 1871-80	33·6	17·8	17·9	14·7

* The boundaries of the districts upon which these calculations are based are not identical with those of the district as included in the former Table.

Without laying too much stress upon the comparison, because of the numerous conditions involved in the question, I append, as

COMPARATIVE TABLE OF THE NUMBERS SURVIVING OUT OF A MILLION BIRTHS UNDER SANITARY CONDITIONS OF DIFFERENT DEGREES.

Age x.	Number Surviving at Age x.					Numbers Dying in the Intervals of Age.					Age x.
	In Healthy Districts.	In England and Wales.	In London.	In Fifteen Great Towns.	In Liverpool Registration District.	In Healthy Districts.	In England and Wales.	In London.	In Fifteen Great Towns.	In Liverpool Registration District.	
0	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	175,410	263,182	305,518	345,816	460,370	0
5	824,590	736,818	694,482	654,184	539,630	29,341	34,309	30,922	32,411	41,009	5
10	795,249	702,509	663,560	621,773	498,621	16,677	17,946	13,642	15,894	15,729	10
15	778,572	684,563	649,918	605,879	482,892	22,571	21,813	19,368	21,536	20,124	15
20	756,001	662,750	630,550	584,343	462,768	28,449	28,705	24,068	25,497	28,271	20
25	727,552	634,045	606,482	558,846	434,497	59,612	62,052	56,723	58,697	74,153	25
35	667,940	571,993	549,759	500,149	360,344	61,921	69,078	76,266	73,154	85,151	35
45	606,017	502,915	473,493	426,995	275,193	71,938	81,800	93,145	88,376	90,969	45
55	534,081	421,115	380,348	338,619	184,224	109,482	112,086	120,616	114,244	86,589	55
65	424,599	309,029	259,732	224,375	97,635	177,391	147,905	135,561	125,440	63,480	65
75	247 208	161,124	124,171	98,935	34,155	177,252	122,559	97,882	81,357	28,152	75
85	69,956	38,565	26,289	17,578	6,003	65 496	36,412	25,020	16,849	5,586	85
95	4,460	2,153	1,269	729	417	4,440	2,141	1,262	724	408	95
105	20	12	7	5	9	20	12	7	5	9	105

NOTE.—The numbers surviving in healthy districts are taken from a Life Table for Healthy Districts, constructed by Dr. Farr, and published in 1859, in the "Transactions of the Royal Society;" the figures relating to England and Wales are derived from the English Life Table No. 3 (based on the mortality during the 17 years 1838-54); and those for London, for 15 great towns, and for Liverpool, are calculated from the mortality in the respective districts during the 10 years 1861-70. The whole Table is formed from selected columns of several Tables in Dr. Farr's Report to the Registrar-General on the "Mortality in the Registration Districts of England during the years 1861-70." (Supplement to 35th Annual Report.)

bearing upon this part of the subject, the following Table, showing the mean age at death in these four districts :—

MEAN AGE AT DEATH OF PERSONS DYING IN LIVERPOOL REGISTRATION DISTRICT, AND IN TWO RURAL REGISTRATION DISTRICTS OF LANCASHIRE DURING THE TEN YEARS, 1871-80.

Registration Districts.	Mean age of all who died.		Mean age of all who died at ages 20 and upwards.	
	Males.	Females.	Males.	Females.
Liverpool	25·6	26·8	48·4	50·6
Garstang	39·4	38·5	62·2	58·5
Limesdale	40·2	41·3	61·9	60·3
Glendale	43·4	46·4	60·8	63·7

This Table shows that, whilst the males who reside in Liverpool, and who survive to 20 years of age, attain a mean duration of life of 48·4 years, those who reside in the adjacent districts of Limesdale, Garstang, and Glendale, attain the ages of 61·9, 62·2, and 60·8, respectively, that is to say, a prolongation of life to the extent of from 12 to 13 years.

(b.) Importance of Analysing Death-rates of a District according to the Sanitary Conditions prevailing in different parts of the District.—When we talk of healthy districts, we must bear in mind that, in most of these districts there exist unhealthy parts, rendered so by removable insanitary conditions; and if we could remove those conditions, we need not despair of obtaining a health-rate, even in what are now called unhealthy districts, superior to that shown by the districts we now call healthy; and, therefore, in considering the question as to how far we may hope to improve the health of the community, we must not content ourselves with averages of large districts, because the death-rate of a large district is made up of the death-rates of numerous small areas, some of which are healthy, whilst others are remarkably unhealthy. But what we want is to ascertain healthiness of each of these more limited areas, in order to see how we can improve them. These areas should be selected with reference to the class of inhabitants and the character of dwellings upon them. The death-rate of the metropolis in the last decade averaged 22·5 per 1,000, with a mean density of 42 persons per acre. In the eastern districts, with a density of 107 per acre, it

amounted to 24·8; whilst in the central districts it averaged 24, with a mean density of nearly half as much greater, viz., 150 per acre. In the southern districts, with a population of 21 per acre, it was 21·8, whilst in the west districts, with a population of more than double, viz., 52 per acre, it was only 20·8 per 1,000. If we subdivide the population into still smaller areas, we find that a large death-rate prevails in some districts, whilst a low death-rate prevails in others close by. Unfortunately, it is not often that the areas on which the population returns are based have any reference to the conditions under which the people are living, and it is very difficult to obtain figures of the death-rate of small districts. It can only be done by selecting a special area, according to the character of the houses and of the population, and following the occupiers to the hospital and the workhouse, so as to obtain the deaths.

As an illustration of the analysis of the death-rates of small definite areas for this purpose, I annex a tabular statement collated by Dr. Buchanan many years ago, in which a comparison is made of two streets—one, Dudley-street, of very indifferent houses in bad sanitary condition; and the other, Coram-street, with houses of similar size and character, but fairly good, and with a mortality equivalent to the high average of the district in which it was situated. The following were the results:—

	Dudley-st.	Coram-st.	Metropolis generally.
Number of houses	82	33	—
Average number of rooms per house	7	7	—
Inhabitants per house—			
Average	21	11	—
Largest number	36	20	—
Total mortality per 1,000	38	29·7	22·5
Diseases — Per-centage of total mortality—			
Zymotic	11·6	—	4·9
Tubercular	9·3	9·1	3·8
Lungs (excluding tubercular)	7	—	4·1
Deaths of children—			
Per-centage of total deaths	58·4	27·2	—

This Table specially exemplifies the result of overcrowding upon zymotic and lung diseases. Thus, in the crowded houses, the whole death-rate was 38 per 1,000, as against 29 per 1,000 in the less crowded houses; the excess being chiefly made up of zymotic diseases and lung diseases.

I append this return mainly for the purpose of illustrating the advantages and importance of pursuing the subject in detail.

The following instances of deaths on limited areas are selected from evidence given before the Select Committee of the House of Commons on the Artisans' and Labourers' Dwellings Act.

In Limehouse, whilst the average death-rate of the population of the district was 23·9, the death-rate of a special part of the district was 50 per 1,000. The density of the population on this part of the district was 514 per acre.

In Whitechapel and Aldgate, there was a district of six acres, which had 625 persons per acre, the death-rate in that part being 50 per cent. above the death-rate of the district. In some parts of the area there were 1,423 persons per acre.

In St. Giles, whilst the death-rate of the northern district was 21·82 per 1,000, that of the southern portion was 33·16 per 1,000. In parts of this district the area was covered with very narrow courts and alleys, with badly ventilated and dilapidated houses, many of them without back-yards, and the rears almost touched each other. In this area the death-rate was 40 per 1,000, as against 25 per 1,000 for the whole district, and 17 per 1,000 for St. George's, Bloomsbury, which is close by.

Mr. Chadwick, some short time ago, obtained information as to the relative health of different classes of the population in Westminster and Croydon; and similar Tables have been got out from Newcastle and Dover.

These show that the mean duration of life of the wage classes in the towns is below that of the well-to-do classes; whilst in the rural or country districts, it does not appear that this difference prevails; and it is, therefore, reasonable to consider that, provided proper accommodation be afforded to those classes, their degree of health and of length of life would approach more nearly to that of the well-to-do classes.

(*c.*) *Deaths of Children an Index of Sanitary Condition of a Locality.*—The mean age at death of the population is largely affected by the infant mortality.

From the Table on p. 583, it appears that the infant mortality for males has varied from 72·2 per 1,000 in the decade 1841-50, to 68·6 per 1,000

TABLE FOR ENGLAND AND WALES, SHOWING THE AVERAGE ANNUAL MORTALITY OF MALES AND FEMALES TO 1,000 LIVING OF EACH SEX AT TWELVE GROUPS OF AGES IN FOUR DECENNIADS.

Ages	All Ages.	0	5	10	15	20	25	35	45	55	65	75	85 and upwards
Decenniads.	Males.												
1841-50	23·1	72·2	9·2	5·1	7·1	9·5	9·9	12·9	18·2	31·8	67·5	148·1	311·5
1851-60	23·1	72·8	8·5	4·9	6·7	8·8	9·6	12·5	18·0	31·0	65·6	146·8	308·4
1861-70	23·7	73·3	8·2	4·5	6·2	8·5	9·9	13·5	19·2	33·1	67·1	147·3	314·7
1871-80	22·8	68·6	6·8	3·8	5·4	7·5	9·4	13·9	19·5	34·7	68·5	147·4	309·5
	Females.												
1841-50	21·6	61·1	8·9	5·4	7·9	9·1	10.6	12·9	16·0	28·4	61·0	135·9	292·6
1851-60	21·4	63·1	8·4	5·1	7·4	8·6	10·0	12·2	15·3	27·2	58·9	134·6	289·0
1861-70	21·4	63·7	7·8	4·5	6·7	8·0	9·7	12 1	15·6	27·9	59·1	134·9	284·9
1871-80	20·1	58·5	6·3	3·8	5·6	6·9	8·6	11·6	15·4	28·8	60 6	133 3	280·0

in the decade 1871-80, and for females, from 61·1 to 58·5 per 1,000; and that the deaths of children under five years are as numerous, in proportion to the numbers living, as those of persons of sixty-five years of age are in proportion to the number alive at that age.

The Tables already appended show the numbers surviving out of a million births, under sanitary conditions of different degrees, from which it appears that in the unhealthy districts 46 per cent., or nearly one-half, die under five years of age; and the very marked difference which appears in the returns which Mr. Chadwick obtained from Westminster and Croydon, of the mean duration of life of the wage classes, as compared with the well-to-do classes, is no doubt largely attributable to the deaths of the young, the proportion of whose deaths to total deaths thus affords a very good index of the sanitary condition of different districts.

In the city of Newcastle, the annual rate of mortality per 1,000 for all ages was, for males 23·15, and for females 20·13; whilst for children under five years it was 66·19 for males, and 54·77 for females. In Dover, whilst the mortality per 1,000 of all classes was, for males, 15·13, and for females 15·37, it was for children under five years, 62·61 for males, and 44·47 for females.

The large death-rate of children and of young persons arises from a variety of causes which it may be difficult entirely to remove; it must, to some extent, be dependent on the health of the parents, but it is often the result of improper food. An instance from the Northern Counties Orphan Institution illustrates this point. The children there have been singularly free, during the eighteen years the institution has been in existence, from children's disorders. Each child has a pint of new milk every day. Some years ago, milk was very dear, and for three months the children received half the quantity, weak tea for the evening meal being substituted. During the latter part of that time, the number of the children who were unwell, from various causes, was greater than it had been for years; the milk was restored, and the orphanage became as free as ever from the usual disorders of children.

But the condition of the surroundings in which children are placed, also materially influences their death-rate. Some evidence of the effect of pure air on children is afforded by comparing the table of mortuary statistics of Newcastle with that of the rural parishes of Northumberland. The proportion per cent. of deaths of children under five years to total deaths in the class of tradesmen and shopkeepers in Newcastle is 37, as against 20·48 for the same class in the rural parishes; whilst for the shipwrights, smiths, and forge labourers' class it is 47·96; and for the other wage and artisans' class it is 41·52 in Newcastle, as compared with 28·72 for the wage and artisans class, and 22·59 for agricultural labourers in the rural parishes. On the other hand, for the seamen and fishermen class in Newcastle the proportion is 26·77; and in the comparison of the death-rates of the two streets which I have quoted above, it appears that in the case of the crowded houses of Dudley-street 58 per cent. of the total deaths were those of children, whilst in the less crowded houses of Coram-

street only 27 per cent. of the total deaths were those of children.

These figures would seem to indicate that, where children can have fresh air, their probabilities of life are much prolonged. And it may be assumed as certain that, where the choice lies between giving young children plenty of food whilst they are exposed to bad air, or giving them little food whilst they are placed in pure air, it would be preferable for their health to select the latter alternative.

This fact is further exemplified from the metropolis. The mortality of children under 10, in the metropolis generally, was 47·66 per 1,000; whilst that of children in the Improved Dwellings, where there is good circulation of air all round the dwellings, was 24·04 per 1,000, or less than one-half.

Moreover, in the buildings of the Improved Industrial Dwellings Company, during a period of 16 years, the death-rate per 1,000 of persons over one year of age was only 10·35 in the Company's Dwellings, whilst it was 17 in the metropolis generally.

The death-rate, in these Improved Dwellings, of infants under one year of age, was even more favourable; for although the birth-rate was 5 in 1,000 more in the Company's Dwellings than in the metropolis generally, the death-rate of infants was only 1·7 higher in the Improved Dwellings than in the metropolis; thus showing that the conditions of occupancy in these dwellings are as favourable for infants as they are for persons of riper years.

The other companies who have built improved dwellings can show eqully favourable results. Inasmuch as infant mortality is a safe index of sanitary conditions, it is evident that the various improved dwellings afford a solution of the question as to how to obtain, in a densely crowded area in the middle of a large town, dwellings in which the poorer part of the inhabitants can live under proper sanitary conditions.

(d.) Necessity of Sanitary Dwellings for the Poorer Classes in Large Towns.—The main efforts of the community in the matter of sanitation, have been hitherto directed to the water supply, the drainage, and the removal of refuse matter from the midst of the population. These were the evils which were most prominent when the question of sanitation was first approached. Within recent years, however, the crowded and insanitary conditions of the dwellings of the poorer classes has forced itself upon public attention. Among the municipalities which have made serious efforts to diminish this evil may be mentioned that of Glasgow, whose efforts have been rewarded with marked success. The law enables insanitary houses to be condemned and pulled down, and the Artisans' and Labourers' Dwellings Act enables municipalities to buy the insanitary property, to pull it down, and let or sell it for the building of improved dwellings on the site so cleared; and, in some cases, to build houses on the cleared sites. If we are to diminish the death-rates of our large towns, and to remove the numerous foci of preventible disease which they contain, it is in this direction that we must now push forward our efforts for improvement.

In London, during the last forty years, we have been slowly improving the dwellings of the artisan and labouring classes. The improvement, begun as a charity, has been proceeded with on a commercial basis.

The distinction between the improved dwellings and the houses which they replace is this. The old houses built close together, often back to back. When let in tenements, the rooms opened out of a common internal staircase. The access was often from narrow courts, without the possibility of circulation of air, without proper convenience for the reception or removal of refuse; consequently the stagnant air was loaded with impurities. The new dwelling accommodates its inhabitants in stories one above the other, the tenements are self-contained, like so many separate cottages, entered from a staircase, open to the air; and, whilst these dwellings place as large a population as the old dwellings did on the same area, they allow space between the houses. The access to these dwellings is through wide yards or squares, where no refuse is allowed to stand or accumulate; and thus there is circulation of air all round them, and the air in circulation is not polluted with refuse. No one can walk from this room through some of the narrow thickly peopled streets in its vicinity on the north side of the Strand, where the mean density of the population is from 190 to 200 per acre, without feeling how much more healthy the streets would feel, and how much more circulation of air there would be, if the population was located in lofty buildings of the type of the improved dwellings.

The political economist tells us that we should leave the provision of dwellings to the ordinary laws of supply and demand; and during the last 40 years some individuals and many corporations have come forward in order

to supply this want. The persons who have thus come forward, although largely actuated by philanthropy, have supplied these dwellings with a view to profit, upon the principle that, unless profitable, they would not be self-supporting, nor would they extend as rapidly as desired.

The result, however, for forty years, has been that we have provided at the present time, in London, only between 11,000 and 12,000 of such dwellings, capable of containing from 55,000 to 60,000 persons. But in dense populations, it is not only as a question of supply and demand that the taking of insanitary property, the removal of the insanitary houses, and the substitution of improved dwellings for the artisan classes in place of those destroyed, can be considered; there is the more important question of the removal of foci of disease from the middle of the community, and after that, the money value to the community of the resulting improved health.

The founders of these improved dwellings appear to pay at the present time on their shares about 5 per cent., but in estimating the profit it must be borne in mind that a portion of their expenditure has been made out of money raised at a lower rate of interest from the Government. Unless the funds for repairs are carefully managed, it is quite possible that, as the buildings become old, this per-centage may not be maintained, and it is not probable, in any case, that a much larger per-centage will be obtained from the investment where the dwellings are *bonâ fide* artisans' and labourers' dwellings. The profit, of course, largely depends on the amount of rent; and the dwellings which have been provided by these companies on a remunerative basis, in the place of those destroyed as insanitary, command in many cases rents above what the persons who formerly occupied the insanitary dwellings can afford to pay, and are, consequently, inhabited by a superior class. The rents appear to vary from 4s. 6d. to 8s. 6d. per tenement per week, or, in some cases, where more rooms are taken, to 11s. per tenement. The Peabody Trustees, however, appear to charge 2s. to 4s. 6d., for which two rooms and a kitchen, &c., are provided.

Lord Shaftesbury, who has done more than any man to promote the well-being of the working classes, said last year—

"Some people say that poor persons should cultivate thrift. No doubt thrift would be a great thing for vast numbers of people, and would tend in a general way to make society much happier; but there are classes for whom thrift is almost hopeless, and those are the classes whose labour is uncertain; who have, perhaps, two months of occupation, and six weeks of idleness. Among these may be counted the dock-labourers, who earn, when in full work, from 17s. to 19s. a week, but whose average earnings, I do not believe, reach more than 9s. a week. How can such people pay the rate demanded for decent lodgings? In cases of this kind the question is how to find a decent room for one man at the rate of not more than a shilling a week. Of all the secondary gifts that could be bestowed on the labouring man, I believe there is none that would so conduce to his happiness, prosperity, and morality, and, at the same time, to the safety of society, as the having a sound mind in a sound house."

The evidence before the Artisans' and Labourers' Dwellings Committee of the House of Commons showed that, in certain parts of London, *e.g.*, the City of London, the cost of property made the construction of artisans' dwellings entirely prohibitory; but in the outskirts of that very expensive area, there are many places now crowded with insanitary dwellings, where improved dwellings could be built; and we must remember that the reason why we now have in our midst these insanitary dwellings, is because we have allowed, in former years, the spaces which existed round the houses to be built over by the owners, for the purposes of profit, without any regard to the effect on circulation of air or on health.

It is to this dereliction of duty by the community in taking measures for the protection of the health of its members, that those evils have arisen from which we now suffer. And this suffering, entailed by this want of consideration, has fallen principally on the labouring class, because they have always, from necessity, been driven to the cheapest, and, therefore, the most wretched, dwellings; and when these have been pulled down, they have again been driven either to crowd together in other old houses in other localities, or to live at a long distance from their work; and the extra exertion of going to and from their work diminishes, to a certain extent, their working capacity.

The extension of railways has enabled a portion of the working classes to resort to the country for houses; and this is much facilitated by workmen's trains.

Some of the building companies above-mentioned have provided dwellings in the country. These consist of a cottage and garden; and there can be no doubt that, in the point of view of health and morality, the

spreading of the population over an extended area, and locating them in separate cottages, each with its garden, is the ideal system which we should prefer to see adopted.

But the persons charged with the sanitary supervision of these new districts must take care that they do not allow the evils, from which we now suffer in our crowded towns, to be repeated in these at present healthy localities. They must regulate the sewerage, drainage, and water supply; they must see to the removal of refuse matter; they must enforce rules to ensure that the open spaces now forming yards and gardens shall be carefully maintained for the circulation of air. Without regulations, those new localities will only repeat the errors from which we now suffer.

The rent of these cottage dwellings is, however, above what many labourers can afford to pay; and, moreover, London is so vast, that although the fact of sleeping in country air is of itself strength-giving, the distances to be traversed in daily going to and returning from work, which distances are necessarily sometimes considerable, diminish, to some extent, the power of a man for work.

There are many industries which require that the persons who practise them should live near the place whence their work is derived, and where it is essential that a man should live on the spot. This is especially the case with persons in trades who take their work home, with costermongers and with dock labourers, the latter having to be on the spot for the chance of employment.

Whilst, therefore, our efforts should be directed to facilitate the exodus of the working population to the outside or into greater London, where they could inhabit cottages, each with its garden, we must not lose sight of the fact that there will still be a large residue to be provided for in the thickly inhabited parts of London itself.

(*e.*) *Where Private Enterprise fails, Municipality should construct Dwellings.*—The commercial system, therefore, whilst it indicates the manner in which the want can be met, does not fully supply that want. I have already shown that, where a large population is located in a town, on a limited area, the conditions under which it can exist are very different from those which prevail in more scattered communities. The inhabitants are more dependent upon each other's well-being; because, where the community is concentrated, its safety from disease is much more dependent than in a scattered community upon preventing, as far as possible, the existence of foci of either moral or physical disease. If we look at the progress of municipal legislation, we find that this is becoming daily more and more recognised; and in most large towns, in proportion as our towns have extended, so have the municipalities extended their functions. Municipalities have long seen that it is for the benefit of the communities which they govern, that they should undertake the supply of pure water and of light. They have acquired powers for regulating the construction of houses, and for the enforcement of certain sanitary arrangements in inhabited buildings. They have the power to condemn insanitary dwellings, to expropriate the owners, to purchase the property, to cause the unhealthy dwellings to be pulled down, and to sell or let the property for new dwellings, and, in the case of some towns, to provide the new dwellings. Private enterprise does not provide capital with rapidity for the replacement of bad dwellings by good ones; and many medical officers have told me that they hesitate to condemn buildings which they consider insanitary, because, if pulled down, there would be nothing substituted, and the occupants would be homeless, or overcrowded into other houses, which would become equally unhealthy.

The municipality undertakes the building of workhouse hospitals, and of fever hospitals; and numerous people in and out of Parliament are urging legislation for the purpose of checking the spread of infectious diseases. But the reports of the medical officers of the different towns show that the principal foci of these diseases exist in the insanitary dwellings of the very poor, and that it is from thence that the larger number of occupants of these and of all hospitals mainly come.

Mr. Burdett states that our London hospitals and dispensaries cost nearly £600,000 annually to administer. The average number of out-patients treated at the various institutions in a year is about 1,000,000—that is to say, more than one out of every four inhabitants of the metropolis becomes an out-patient in the course of the year.

This expenditure is incurred mainly for the purpose of patching up the wretched poor, who live in the dwellings to which I allude, and who have been injured by bad drainage, want of ventilation, darkness, &c.; for though drink may be one of the immediate causes of many hospital cases, yet the tendency to drink is created and fostered by the wretched dwellings of the very poor. But besides the

time lost by the sickness itself, there is the large amount of time wasted by the poor in going to and waiting at hospitals, which would be spent by healthy poor in labour. There is, moreover, the great amount of lassitude and idleness in the low-class poor, which Dr. Richardson traces to want of ventilation, in their own and former generations.

A few years ago, the communities awoke to the necessity of abolishing the cesspools under houses, and of constructing sewers to receive the matter they used to contain. In the case of large towns, where a dense population has been allowed to grow up in closely packed dwellings on a restricted area, the blocks of insanitary dwellings may be termed moral cesspools, and the community has itself to blame for having permitted and even fostered their creation in its midst. It is as important to the well-being of the community that these moral cesspools, which are foci of disease, should be removed from its midst, as that works of drainage should be constructed. It is not, therefore, sufficient to give the medical officer of health the power of condemning insanitary dwellings, or for the municipality to pull down those buildings; but it is essential, in order that the nation may make adequate sanitary progress, that when insanitary buildings are pulled down, and when private enterprise is not ready to step in, the municipality should be required to provide new and improved dwellings in the place of those condemned; and that the rents for these dwellings should be fixed on a scale to allow of their occupation by the very poor.

It is not in any way as a philanthropic measure that I advocate this, but as a measure of sanitation, of economy, and of protection to the rest of the community.

It is manifest, from the experience of the companies who have erected these dwellings, that the condition of the population located therein is as healthy as that of the occupants of the healthiest parts of the town, although the number of inhabitants per acre is as great as that of the densest parts of the population; and the same experience shows that, even with the low rents which the very poor may afford to pay, the cost of maintaining them, together with a moderate percentage, can be obtained on the capital expended.

The population of London amounts now to nearly 4,000,000, and will, at its present steady rate of increase, amount to 6,000,000 before the end of the century. Consider, for a moment, what this means. It is double the population of all Switzerland: it is more than the population of Egypt or Belgium.

We insist upon educating the children of the people, and we place the children, during their school hours, in airy, spacious rooms. But follow those children, who live in the more densely-crowded parts of this city, to their homes in confined courts, without circulation of air; their playground in the court or street—often in the midst of refuse—and learning, from the example of the parents, that the only comfortable place is the gin-palace and the music-hall. It is not sufficient to content ourselves with giving education to this population; the education will be dangerous rather than beneficial, if we allow the wretched dwellings which exist in so many parts of this vast metropolis to continue to exist. We have abolished the cesspools, which bred fever and intensified the plague of cholera; we must now abolish the wretched dwellings, which are moral cesspools, and which intensify moral disease by fostering crime and discontent.

If the education which we now give so lavishly is to produce beneficial fruits, we must attend to the material comfort of the people, as well as to their moral training. The provision of proper dwellings for the people is the natural complement of the measures which have been passed for the education of the people.

(*f.*) *Money Value of Diminished Death-rate.*—But let us dismiss all consideration of the moral advantages of properly housing the poor, who, in their present dwellings, only foster dangerous diseases in our midst, and look at the question solely in its commercial aspect. The removal of the insanitary dwellings, and the location of the poor in sanitary dwellings will diminish sickness, and increase the wage earning power of the community.

In order thoroughly to realise the value of the economy of sanitation, we must translate it into figures. Each death has been estimated to cost in funeral expenses about £5, and consequently, in the metropolis, which will soon have a population of 4,000,000, a diminution of the death-rate by 2 per 1,000 means, in the first place, a direct money saving of £40,000 a year from this cause alone. There would also be the saving from sickness, because the amount of sickness follows in some proportion the number of deaths. We shall certainly err on the side of understating the question rather than overstating it, if we

take for this loss an assumed amount derived from life assurance tables. It appears from Mr. Neison's Tables, derived from the records of the Ancient Order of Foresters, that a sum of £40, paid at 20 years of age, will ensure £1 per week during sickness for the whole life. The annual interest on this sum at 5 per cent. is £1 per annum.

The loss from sickness arises partly from the loss of earnings, and, in the younger members of a family, from the expense which the sickness causes, from loss of time and otherwise, to the other members of the family; and an average of ten shillings a week would probably represent the average loss occasioned by sickness all round. If we assume the sickness to follow the death-rate, the diminution of 2 per 1,000 may be estimated to cause a saving of one shilling per head per annum of the population, as the measure of the loss during sickness, arising from preventible diseases, in the earnings of the heads of families, and in the extra expenses caused by the other members of a family. Thus the diminished sickness-rate on the population of 4,000,000 would afford a beneficiary advantage to the population of at least £200,000 a-year; or the advantage to the population from a diminished death-rate of 2 per 1,000 would amount to nearly a quarter of a million a-year.

If by abolishing the moral cesspools and foci of disease I have mentioned, we could reduce the death-rate to the level of that of some of the most favourable towns, the direct saving from diminished sickness and funerals would be nearly half-a-million. This would pay the interest at 4 per cent. on £12,500,000, which would afford ample funds for the erection of proper houses for the poor. The question may be considered in another way. The Table on the next column shows how the numbers living at each age would be increased, if the deaths from zymotic or preventible diseases could be excluded.

The Table may read thus:—Of 510,622 boys born alive, 321,013 attain the age of 25, of whom 30,258 die in the ten years following. Exempted from attack by miasmatic diseases, 374,838 would survive to the age of 25; 31,164 dying in the next ten years.

Applying this Table to the population of the metropolis, where the number of male births in 1880 was about 68,000, at the ages of 20 or 25, when a labouring man attains his full earning power, there would be about 3,670 more male persons living, out of the persons born in one year, if preventible diseases were

ENGLAND AND WALES.—FOUR ORDERS OF LIFE TABLES FOR MALES (CALCULATED FROM THE FACTS RECORDED DURING THE TEN YEARS, 1861-70), SHOWING THE EFFECT OF THE EXCLUSION OF DEATHS FROM (1) THE PRINCIPAL ZYMOTIC DISEASES; (2) PHTHISIS; ON THE PROBABILITIES OF LIVING FROM AGE TO AGE.

Age x.	Living at Each Age x.			Dying in Each Interval of Age.		
	To die of All Diseases.	The principal Zymotic Diseases Excluded.	Phthisis Excluded.	Of All Diseases.	The Principal Zymotic Diseases. Excluded.	Phthisis Excluded.
0	510,622	510,622	510,622	142,805	99,272	140,277
5	367,817	411,350	369,645	14,688	7,479	13,997
10	353,129	403,871	355,648	7,788	5,934	6,798
15	345,341	397,937	348,850	10,474	9,533	6,857
20	334,867	388,404	348,850	13,854	13,566	7,725
25	321,013	374,838	334,268	30,258	31,164	18,868
35	290,755	343,674	315,400	36,617	39,107	28,010
45	254,138	304,567	287,390	44,313	48,806	40,708
55	209,825	255,721	246,592	58,981	67,133	63,367
65	150,844	188,588	183,225	73,435	87,442	87,279
75	77,409	101,146	95,946	59,583	76,002	73,695
85	17,826	25,144	22,251	17,037	23,948	21,305
95	789	1,196	946	780	1,187	937
105	9	9	9	9	9	9

abolished, than is now the case; and at the age of 45 there would be about 3,400 more males living; at the age of 55 there would be 6,133 more; and at the age of 65, when a man's working power may be assumed to be on the decline, there would still be above 2,500 more males alive who had been born in the same year. The community may thus be assumed to have had the benefit from the capacity for work of these extra persons during the 45 years. The money value of this may be roughly assumed from a calculation of Dr. Farr's, in a paper published in the Statistical Society's Proceedings of 1853, on the equitable taxation of property. He there gives the value of high agricultural wages, and of moderate professional incomes. The value of the future wages of a labourer, at the age of 20, on high wages, is there stated at £637, and the value of the future income of a professional man, earning the moderate income of £288 a year, is stated to be £5,329 at the age of 25, and £6,038 at the age of 40. If we assume that one-tenth of the males were of the class above that of labourers, the pecuniary advantage to the community from the abolition of zymotic diseases, arising from the earning power of the large number of

males who would be kept alive out of those born in each year, who would otherwise have died, would be represented by about £4,500,000; and this would be repeated annually. These figures show that there is a direct money value to the community in preserving the health, and extending the duration of healthy lives of those who live in the community, because it extends their power of labouring and of adding to the wealth of the community.

The large expenditure which the nation has already incurred for sanitary improvements, has thus had a direct money value to the community very far in excess of the actual expenditure; and it is evident that, in the reconstruction of insanitary dwellings by a municipality, even if the rents failed to return the full interest on the capital borrowed, the community would be amply repaid by the saving from sickness, and the earning power arising from improved health.

I have already shown that the health of a district, as measured by the published death-rate, is made up from the average of a number of details; and that, whilst there are in some places healthy parts of the district, there are in others unhealthy parts. It is the unhealthy parts which we should attack; and in London and all great towns, the unhealthy localities are generally the crowded dwellings of the very poor, where circulation of air is impossible, and where in many cases the removal of refuse is difficult. In every locality where we find a death-rate of above 18 per 1,000, we may be sure that there is a margin upon which we can work.

III. Influence of Uniformity of Administration on Sanitary Progress.

In conclusion, if there is one thing more than another which is important for securing sanitary progress and economy in sanitation, it is that we should have unity of administration. Without that much work is wasted, progress is impeded, and often useless expenditure is incurred.

In the early days of London sanitation, the first stages taken in consolidation were the creation of the Metropolitan Roads Commission, and the consolidation of the various Courts of Sewers under the Metropolitan Commission of Sewers; but at the formation of the Metropolitan Board of Works, the care of the roads in each parish was placed under the vestry of the parish. The sewers, with the exception of the main sewers of the metropolis, were placed under the jurisdiction of the separate vestries. The main sewers were consolidated under the Metropolitan Board of Works; except in this latter respect, the jurisdiction of the City of London remained generally what it had been previously. Thus there was not created any uniformity of jurisdiction in the metropolis in some of the most important matters relating to sanitation; but, indeed, a contrary course was pursued.

There can, therefore, be no question that the Metropolis Local Management Act was a retrograde step in sanitation. Wherever there is a large community concentrated on a limited area, it is quite certain that uniformity in sanitary administration is necessary for the safety of the community. But the concentration is also necessary in an economical point of view. The present system cannot be called economical, because the cost of the salaries, or mere establishment charges of the officers of the thirty-eight parishes and districts outside the city of London, into which the metropolis is divided, amount to nearly £100,000 a year, exclusive of the cost of the Metropolitan Board of Works, of the staff belonging to the City of London, or of any actual work of sanitation.

An examination of the accounts of several vestries shows that a large saving could be effected by means of consolidation. But what is far more important than the money saving, is the fact that absence of uniformity in the sanitary administration of the metropolis is, of itself, a great barrier to sanitary progress. There is not, however, space in the limits of this paper, to enter fully into this important question; but I shall hope, at no distant period, to discuss it more at length. Meanwhile, I will only observe that we are now promised a new Act of Parliament for consolidating the government of London under one administration; and it is most important, for securing efficiency and economy in sanitation, that advantage should be taken of this Act, to give the necessary degree of concentration to the administration of the sanitary services of the metropolis.

DISCUSSION.

The Chairman said it had pleased him very much to find that Captain Douglas Galton appreciated the necessity for this question of sanitation occupying the attention of statesmen, and until statesmen understood that the care of the poor, both of their health and morals, was their duty, it was useless to hope for much progress in this respect. He quite agreed that education—though he would say nothing against it—was but one part of the story. It gave persons

intelligence to know and understand the enormous differences in the condition of the human family, and make them draw conclusions which were by no means favourable to the safety and stability of the State, which must depend on the content of the inhabitants. It was absolutely impossible to have stability if people were permitted to live in the state in which many present besides himself knew that they did live; and he did not wonder at uprisings against authority when he knew that the poor concluded that they could not look for any benefit under existing conditions. He did not want to preach socialism, but there must be more of the spirit of socialism in the nation before we could have progress. Those who had travelled or read must know that at the present moment the vast mass of the population of the world had been, and was housed in the most wretched manner possible. It was so all through China, India, Russia, and Europe generally, including Great Britain; and as to the condition of the favourite winter quarters of the rich on the Continent, every winter sickly people who had the means went to the South of France or to Italy for their health, but very often they contracted disease and died. Captain Galton had recently reported on one of the favourite resorts in the South of France, where he found no drainage, but a mass of cesspools even attached to the best hotels, the consequence being frequent outbreaks of typhoid fever. One practise existed on the Continent which he wondered did not prevent people going there at all, and that was the heavy fine levied upon those who, by reason of cesspool air, became ill and died, the relatives being heavily fined by the hotel proprietor because of the death. He knew of one case in which a lady went abroad and died at Florence, and her family had to pay something like £100 in consequence.

Mr. CHRISTIAN MAST remarked that the Continent was a large place; it was well known that there were some places on the Continent which were the healthiest in the world, and he did not see that it was necessary to hold up the Continent as an example of everything which was bad in sanitation. One point on which he had long considered English sanitarians in fault, was in allowing of the congregation of young children, from three to six years of age, in schools. They could not possibly learn at that early age, and play was out of the question in a school-room, and, consequently, the whole of the time was wasted, and it was very detrimental to health. Besides, that was just the age when infectious diseases were most likely to spread, and if one child in two or three hundred got scarlatina, it was impossible to say how far it would go. It had been always a wonder to him that in a practical country like England, such a state of things had been allowed.

Mr. W. BOTLY said that every paragraph in this valuable paper was well worthy of consideration, but he would especially direct attention to that part which referred to the duty of sanitary authorities to prevent the encroachment by buildings upon open spaces in towns. In every city or town almost in England you might find places which, within living memory, were open spaces or gardens, but were now covered with buildings, often tenements of a very small description, and enormously rented in proportion to the accommodation provided.

Mr. C. N. CRESSWELL said this paper was so full of matter that he should have liked, before speaking upon it, to have had some little time to digest it. There was a clearness, precision, and statistical accuracy about it which made it like a proposition of Euclid, and it proved to demonstration what the author set out to establish. A more pungent truth was never uttered, even in that room, than the motto which stood at the front of every sanitary institution, *Salus populi suprema lex*; and if he might paraphrase that, he would say it meant that the health of the people ought to be the rule and guide of all Governments. But how far did our present Government carry out that idea? All would agree that Government never ran ahead of public opinion, and he did not think it was its duty to do so; and until public opinion was thoroughly formed on any matter, it was neither the duty nor the interest of the Government to anticipate it by premature legislation. On some subjects, however, public opinion was pretty well made up, and he agreed with Captain Galton that great strides had been made in the last ten years, especially in what might be called domestic sanitation. The reason was obvious—viz., that the evils of sanitary defects come home to every one, and what appealed to the senses would always have more effect than any amount of reasoning founded on the most unimpeachable statistics. A sentiment on this question was now being aroused in the public mind, and was affecting their actions, particularly that portion which owned house property; and that sentiment was, that when a house was put into a sanitary condition, it possessed an additional money value. During the last year, he was looking for a house, and, of course, having given some attention to sanitation, he wanted to find one which fulfilled the necessary conditions. He looked all round the suburbs, and at last found an owner of house property to the extent of about £12,000 a year, who had taken the trouble to advertise, that during the last seven years, in building his houses, he had, as far as possible, complied with the conditions laid down by the Society of Arts in its Health Congress. He examined for himself, but not relying on his own judgment alone, he called in an experienced architect to examine the house, and, somewhat to his surprise, the report was, that not only the particular house in question, but all in the street, were sanitarily equipped in every way. On the other hand, he must say that although domestic sanitation had made progress, there were other departments which affected the public health quite

as much, if not more, in which there was not only no progress, but rather retrogression. It was not only necessary to have healthy dwellings, but also wholesome food; the first requisite, which was pure water, and how could that be attained, without purifying the rivers. In 1876, an Act was passed to prevent the pollution of rivers, which every one knew was a most lame and impotent piece of legislation. The Government had put the power of enforcing the Act in the hands of the sanitary authorities, who were notoriously the worse offenders; and, therefore, it it was no wonder that the Act was not put into operation; in fact, it had become a complete dead letter. Captain Galton had alluded to the foci of diseases, and that was one of the most important points in the paper, because it was useless to talk of twenty-two or twenty-eight per thousand as being the average death-rate, when in some part of the district there might be a small area where it was twice or thrice that, the real average in the main portion being, perhaps, as low as thirteen. For instance, taking the district of Gray's-inn-lane, Father Fitzgerald, an active Roman Catholic priest, who laboured there, and who was examined at the first commission under the Artisans' Dwellings Act, gave the following evidence. He said that, in order to collect information, he called together the aristocrats of his districts, and on the Commissioners asking who they were, he said they were men who lived in two rooms, and there were twelve in about three-quarters of an acre; the rest of the population lived in one room. Only one house in five had any water, and none of it was fit to drink, but the people took such care of what there was, that they never had an opportunity of washing unless it rained. Now, as one of the first requisites to health was cleanliness, it was obvious that such a state of things would account for a great deal of disease. Very recently he was present at a meeting of the Council of the Chamber of Agriculture when the Rivers Conservancy Bill, which was expected to be introduced, was considered. The object of the Bill was to give powers to conserve rivers, both in volume and purity, and to remove obstruction, but precisely the same mistake was made as in the case of the Rivers Pollution Bill, and the effect would inevitably be that it would also become a dead letter. There had been originally powers for the Conservators to put in force the Rivers Pollution Act, but it was withdrawn for fear of offending the manufacturing districts. There was also a definition of solids, which excluded all matters held in suspension, though they were the most frequent sources of pollution. All these things showed the necessity for still further educating public opinion, and thus stimulating Government to carry out those great measures on which all future progress would depend.

Mr. E. C. Robins thought the main feature in the paper was the proof given, by statistics, that what had been done in the way of sanitation had not been in vain. It was sometimes difficult to meet the objection commonly put forward, that there were many places where the public health was just as good as in the most carefully prepared districts; and that those houses which professed to be so healthy, did not make the occupiers live longer than they used to in old times, before sanitation was thought of. Such objections could only be answered by statistics, such as had now been brought forward. They had always felt that Dr. Farr's tables on the subject of the density of population contained facts which it was very difficult to get over, but the explanation now given of the advantages which had come from the introduction of sanitary measures, and the facts as to the duction of the death-rate in the most densely populated districts, added greatly to the value of Dr. Farr's labours.

Professor De Chaumont, F.R.S., after complimenting Captain Galton on the character of his paper, said statisticians could no doubt pick holes in the figures he had given, but the broad fact remained, and could not be shaken, that there had been a vast improvement, especially in the metropolis, and this was, to all appearance, the result of sanitation. The way in which Captain Galton had shown that notwithstanding the enormous increase in the density of the population, the public health had actually improved, and the death-rate diminished, was extremely important. The fact that that during the last twenty-five years the density of population in London had doubled, was very remarkable. At the time of the investigation into the health of the army in 1867, statistics were obtained from the Registrar-General's Office showing that in London the density of population was such that there were 160 square yards to each individual; but, in 1877, that space had come down to a little over 90 yards. According to the usual rule, that would have been accompanied by a greatly increased death-rate, but such was not the case. That the influence of density of population on health was very considerable might be shown by comparing the two greatest cities in Europe—London and Paris. In Paris, every individual had an area of about 40 square metres, but in London there were 80, and the result was clearly shown, not only in the lower death-rate in a larger population, but also in the character of the diseases. In London, there were some diseases which were more severe than on the Continent; scarlet fever, for instance; but, on the other hand, typhoid fever and diphtheria were much more common and fatal in the large cities of the Continent than they were in England. He recently had a visit from a friend who occupied a high position in the sanitary world in Paris, and what most struck him, was the vast difference between the condition of things in London and Paris. In London, he said, the streets were filthy, and the sewers abominable, but the houses were the perfection of cleanliness; whereas, in Paris, one might give a dinner party in the sewers, and the streets were perfectly clean, but the houses were abominably filthy. In Paris, all the filth was kept in or under

the houses, whilst here it was all sent away; and the result was shown in the differences in health of the two cities, especially in such a disease as diphtheria, which was described by French sanitarians as the scourge of the country; while here it took a comparatively low position in the class of zymotic diseases.

Mr. H. H. Collins, in proposing a vote of thanks to Captain Galton, said he thought economic sanitation would be best evidenced by the improved habits of the people, especially in regard to sobriety, and the refinement of their amusements. Though the paper contained some original matter, a great part of it could not be considered new to any one who had studied the subject, and there were one or two points to which he must take exception. One was where it was proposed that municipal authorities should take in hand the building of artisans' dwellings. Having had a large experience in parochial matters, he thought this would be looked upon by the ratepayers as another mode of imposing additional poor-rates. It was a mode of obtaining what was no doubt desirable by a kind of side wind, but he did not think it would commend itself to the public generally. Another recommendation was that the internal drainage of houses should be put under the control and supervision of the vestry or sanitary authorities. He could only say that he did not find that the external sanitary arrangements under these bodies were absolutely successful, and the great difficulty, of course, was efficient supervision. This kind of paternal government, by which it was proposed to do everything for other people, did not commend itself to him as being English, wise, or proper. It was much better to leave people to themselves, taking every means, of course, to educate them. Sanitation was making great progress, as was shown by advertisements of house property, which now very generally contained a statement that sanitary arrangements had been supervised by some eminent authority. This showed that the public were becoming alive to the importance of the matter, and if that were so, they would soon take care not only that their houses were properly embellished in the Queen Anne, or some other modern style, but also that the sanitation was as perfect as it could be; they would follow Mr. Cresswell's example, and avail themselves of sound professional advice on the subject. He should like to quote some figures recently given by Sir Lyon Playfair as to the death-rate in London at different periods. From 1661 to 1669 it was 80 per 1,000; 1681-90, 42; 1746-55, 35·5; 1846-55, 24·9; and 1871-80, 23; so that, leaving out the years of the plague, and taking the figures from 1681, the deaths had diminished one-half. Since the habits of the people, with regard to intoxication, had not improved, that might fairly be considered to be the result of the sanitation which had been going on during the interval.

Dr. Browning, in seconding the vote of thanks, referred to the point of sanitary authorities looking after the preservation of open spaces in towns and villages, and said that these authorities, though fully alive to the importance of this question, found their hands very much tied, their power not being compulsory, but only permissive. The word *may* usually took the place of the word *shall*, and unless an Act was passed which compelled them to take the necessary steps, in a few years the opportunity of doing what was so much to be desired would be gone.

Mr. Storr said the point raised by Mr. Collins with regard to local authorities erecting artisans' dwellings was a very important one, and Captain Galton would, no doubt, feel somewhat disappointed that it had not been further discussed. One view of it was this, that to a large extent it would be giving a bonus to employers of labour in the particular district. If these buildings were erected on ground which could be more profitably devoted to other purposes, it would be practically making a present at the public expense to the employers of labour which was required in the neighbourhood. He would also take exception to the inference which seemed to be deduced at the close of the paper, that there was no alternative between administering London as it was at present, by thirty-eight Vestries and District Boards, and amalgamating them all in one. There might be a middle course, which might possibly do more to develop municipal life than concentrating all municipal administration in the hands of one body.

The vote of thanks was carried unanimously, and the meeting adjourned.

Mr. Edwin Chadwick, C.B., writes as follows:—

East Sheen, April 26th, 1883.

I regret my inability to be present and take part in the discussion to-night on Captain Galton's paper. I should observe that the obstructions to sanitary progress most extensively prevalent are, the first expenses of the works, often aggravated by unskilful plans, defective execution, and ill-distributed charges. We have to meet these objections by better administrative securities for economy, and we have yet to display against them the great set-off of the expense of preventible disease, of which politicians are generally unaware or heedless. My *confrère* of the Institute of France, M. Jules Simon, lately brought before the Academy a description of the extreme wretchedness of the population of one of the slums of Paris. I called attention to the fact that that was, from its condition, an expensive population—the death-rate was 40 in 1,000. I observed that, by sanitation, the death-rate might be reduced to that of a well-to-do district in Paris, or less than 16 per 1,000, the death-rate of the model dwellings in London. There was, therefore, an excess of twenty-five deaths, and the expense of twenty-five funerals annually, which at the usual rate would be attended by an excess of some 625 cases of sickness, all of which would have to be paid for by

the public, together with the expenses of crime and disorder, generated by the defective sanitary conditions. A physician has followed up this course of exposition of preventible disease at the Academy of Medicine, where he showed that the expenses of a late epidemic attack of typhoid fever could not have been less than one million sterling to the population of Paris. By the sanitary regulations enforced by the police, the common lodging-houses of London, formerly its chief fever nests, have been almost entirely cleared of fever; entirely of fever of spontaneous origin, at a cost which must have been greatly below the expenses of the fever, and consequent heavy death-rate.

It has to be maintained, as a rule, that a comparatively heavily death-rated population is a comparatively expensive population, as well as a sickly and weakly population. In other words, a lightly death-rated population is a comparatively strong and inoffensive population. These propositions admit of every large and distinct illustration.

To take one, that of the present sanitary condition of the metropolis, under its disjointed vestratised administration. I state that under unity of an effective sanitary administration, there is no valid reason why the general death-rate may not be reduced to that of Dover and other urban districts, where the death-rates, which were once as high as twenty-eight in a thousand, have been brought down to sixteen in a thousand, under local unity and better local administration. That is to say, that the death-rate of the whole of the metropolis, taking Dover as an example, may be reduced by at least six in the thousand; and that, for its five millions of population, would be a saving of the annual expense of 25,000 funerals; and moreover, as there is, on the average expense of friendly societies, some twenty cases of preventive sickness for every premature death, there would be a saving of 625,000 cases annual, at an expense of three-quarters of a million of money. But the expense of such a sickness-rate, in labour and wages lost by premature disability to work, is proved to be more than double that sum, large as it seems. It would, indeed, be very difficult to get out the whole of the expenses to which the people of the metropolis are subjected, by the present disjointed and wasteful administration. A properly constituted administration under unity, would save a great part of the expense of voluntary charities now expended upon fever hospitals, small-pox hospitals, and general curative hospitals, for the mitigation of those diseases which are the consequence of low sanitary conditions; for the greater part of all (except those for accidents and surgical cases), it is estimated that upwards of five millions of money are subscribed in this metropolis, independently of the poor relief.

There can be no doubt, on a close examination, that the expenses attendant on excessive death-rates, will largely cover the expenses of efficient works of prevention under a competent administration.

EXTRA MEETING.

The discussion on Mr. H. Trueman Wood's paper, "The Government Patent Bill," was resumed on Tuesday evening, April 24, 1883; Mr. R. E. WEBSTER, Q.C., in the chair.

Mr. BOULT said if the provision that a patent should only include one invention were construed narrowly, it would restrict patents to something very small; unreasonably so, considering that the total cost of a patent proposed was £154. In America they knew patents were cut down to something very small, but there the cost was only £7 or so, and if the English patents were to to be reduced to the same limit, a proportionate price should be put upon them. It was to be presumed that the present law officers would, to a certain extent, give decisions on this point at the outset, and if they took a narrow view of the meaning of it, their decision would probably be followed. It was, therefore, very important that, if possible, some satisfactory definition should be given in the Bill itself. Provisional protection was to be given for twelve or fifteen months, instead of six months, as at present; but the present term left inventors six months behind in making searches, and if this time were extended as proposed, inventors would be over a year behind date. He agreed that all patents ought to be granted for seventeen years. As to the object of putting claims and drawings in the provisional specification, he did not think it could be doubted. It went to reduce the extent of the specification, and to enable whoever had to decide on patents to cut them down to a very fine point, and to confine the final specification to a very small matter. All seemed to point in one direction, viz., to reduce the extent of a patent to the smallest possible scope. He would suggest that it would be well to introduce some means by which the widow or representative of an inventor might apply for a patent, although the inventor were dead.

The CHAIRMAN said he thought Section 12 *b*, was intended to meet the case, though, no doubt, some verbal amendments were desirable.

Mr. BOULT continuing, said he did not see that "racing for the seal" would be cured by the new Bill. It said the patent should date from the application, but it did not prevent that, if a man got the seal before the first inventor, he should not have the power, under the decision of Bates and Redgate, to prevent the first applicant getting his patent at all. Would it not be better to make all patents date from the time of application, and settle the matter of priority, if two were filed on the same day, by the earlier number. Two months for opposition seemed a long time, and if this were allowed, would it not be well, as was suggested at the meeting of the Institute of Patent Agents held the previous evening, that any opposition should be brought forward within two months of the filing of the application. This would also give the advantage that anyone who wished to oppose, would

know he had to oppose within two months from the date. As a matter of convenience, he believed it would be a very good thing if it were possible to make the document more like the American in form, the first page containing the document itself, and the following ones the specification. This was a great convenience in American and German patents, whilst our own parchments were very useless. The American document gave on the first page, the title and the date. He quite thought the patents should be good against the Crown; if not, it would necessarily tend to prevent inventors working in the direction of anything likely to be appropriated by the Crown. He would suggest also that all payments should be made at the Patent-office, not some there and some at Somerset-house, as at present, which often caused great inconvenience. He saw no reason why stamps should be affixed to the documents themselves, or why the receipt for the payment of the fees given to the inventor or his agent should not be sufficient for all purposes. It often happened that letters patent were lost, and then duplicates had to be obtained at great expense. It was quite right that fees should be paid within a reasonable time after date. He thought it would be better to abolish the provisional specification altogether, and start with the complete specification, as in America, than retain the provisions of the proposed Bill. Under the Act of 1852, there was an advantage in the provisional specification, because you put it in broad language, without tying yourself to details, and you then had an opportunity to work out the invention; but if you were to be tied down so closely as was proposed, it seemed to him it would be better to file the final specification at once, and thus save time and expense.

Mr. William Carpmael was sorry to see that the Bill still left the Patent-office without any real head; there was to be a Comptroller, but when anything of importance was to be done, he was to go to the Attorney-General, or to the Board of Trade. Neither one authority nor the other was satisfactory. The Patent-office ought to be able to settle its own business within itself, and when there was an appeal, it should be to the Court of Appeal. It was most difficult, at all times, to get appointments with the law-officers. A case now on hand had been standing over for at least two months for an appointment, and this would become a most serious matter, because if the Bill passed in its present form the number of appeals would be very large. In the provisional specification, a person had to state at once what was the claim on which he intended to substantially abide; and then nine months after, the fight would come as to whether the claim put forward in the final specification was substantially the same as that in the provisional specification. On that question very large sums of money would frequently be spent, for unless the claim in the amended form could be allowed, the invention was lost. It generally would not be possible to make a new application, for usually the invention would have been already published. Whether the claim put forward nine months afterwards was substantially the same as that put forward in the first instance, would be a question constantly arising, and a question very difficult to decide. That brought him to a point of why there should be claims at the outset in provisional specifications, though, speaking as a patent agent, it was not for him perhaps to say a word against this. A careful inventor, with this clause in the Act, would never think of taking a step without having professional advice when that step bound him for ever afterwards. One of the great defects in the present law is that the invention is too rigidly fixed to a claiming clause; he might describe a new and valuable invention, and after having given every information of it to the world, he might lose it in consequence of not having properly defined his claim. The law at present only permitted a person to cut away, but not otherwise to adapt his claim to the invention described in his specification. Instead of going forward they were going back, because at the present time they had six months in which to make the claim, and it was now proposed that that should be done at once. No doubt there were a great many good points in the Bill, but he would not dwell upon them, because in these matters gratitude was the hope for favours to come.

Sir Frederick Bramwell, F.R.S., said they must all agree that the Government were sincerely desirous to give a good Patent Bill, and that they recognised, for the first time, that patents instead of being something to be grudgingly awarded, had really to do with the advancement of the manufactures and the industries of this country. But while he was glad to be able to say that the Government Bill contained certain improvements on the existing law, he was on the other hand constrained to state that some of its provisions were so bad, that if the question were whether they were to remain as they now were, or were to be compelled to have the whole Bill, and nothing but the Bill, he for one, honestly believed they had better remain with the law of 1852 than have the Bill now proposed. But having regard to the excellent spirit in which the President of the Board of Trade had introduced the Bill, he could not doubt that if they could go before him with a unanimous desire as to the alterations that were required, it was certain they would be courteously received and attended to, and it was to be hoped that many of the matters which in their judgment needed alteration, would be altered when the reasonableness of their wants was pointed out. With respect to the points of improvement as compared with exisiting law, he understood, by the present Bill, it was intended, although the language was not quite clear upon the point, that the life of an English patent was not to be dependent upon the life of a foreign patent for the same invention. That was one of the great blots of the

existing law, and if that were cured, no doubt a great improvement would be effected. The extent of examinations proposed to be given, stopping short of any examination into novelty, was also an improvement, but the full value of this to a patentee, when he brought an action in support of his patent, was not given by the Bill as it ought to be. The power of making application by post would also be of great use. With respect to the extensions, it was still left in the hands of the Privy Council, though he gathered the Privy Council were hereafter to have some regard to the value of the invention, and were only to take into account, when estimating the profits made by the applicant, the profits made as patentee and not as manufacturer, assuming the patentee to be a manufacturer of the patented invention. Hitherto the Privy Council had merely considered whether the inventor had realised a hard and fast sum of £10,000, and of late years had not discriminated between this sum having been made from royalties alone, or from manufacturers' profits; and without at all taking into consideration the amount of capital which he had risked in the venture, or the value of his own time, so that no matter what the importance of the invention, a return of £10,000—£700 a year for fourteen years—was held to be a sufficient reward. He was glad to find that the proposed Bill provided that this mode of assessing the amount should be discontinued. Upon the other hand, it said to the Privy Council, in all other respects be good enough to go on as you have been going on. One of these practices of the Privy Council was a very hard one—the imposing the costs of the opponents upon an applicant who had been unsuccessful in obtaining an extension. He would now go to the defects of the Bill, and would endeavour to state them in the order of their gravity. The one of all others which appeared to him to be the worst was the necessity of making a claim in the provisional specification. It really looked as though those who drew the Bill must have been unacquainted with patent matters altogether, and not able to discriminate between the stating the nature of the invention in the provisional, and the stating the claims to be founded on the invention. There was a most distinct direction in the Bill as to that, and a form of schedule which had to be filled in, made it clear the claims must be stated. Everyone who had acquaintance with patent matters knew that claims ought to be made after the greatest deliberation, and should not be demanded until time had been given to experiment and to work the matter out. And even when claims were drawn after the six months' interval had elapsed, how often has a patentee, afterwards, to say, "If I only knew as much as I do now, when I framed my claim, I would have framed it in a different manner." If this be the condition of things, when a claim is drafted, after six months' reflection, what would be the condition when a patentee has to frame his claim at the very outset. According to the Bill, if the inventor made a mistake in the claims in his provisional, there was no means of curing this mistake afterwards. There was no power of amending the claims; there was power of excision, but none of amendment, and he agreed with Mr. Carpmael that this was a very bad blot in the Bill—in fact, the worst blot. He also quite agreed with Mr. Carpmael that the Bill did not provide for constituting the Patent-office in the way which the importance of the subject demanded. There was probably a well-founded fear that at the outset there would be a considerable reduction of revenue and an increase of expenditure, and he presnmed the Government were not prepared to face the further increase which would arise by having three properly qualified persons, whose time would be fully occupied by the work that would be inevitably thrown upon them. With respect to the time of these qualified persons being fully occupied, there was no doubt that there would be an increased number of patents applied for, and the result would be that there would be a great deal of extra work which it would be impossible for one man to deal with. He feared that the Government did not even yet fully appreciate the enormous value of patents to manufacturers, and they were oppressed with the fear that the £140,000 a year clear profit that had been derived from patents was going, and the further fear that there might, for a few years, be a loss—a loss they did not wish to increase by appointing three thoroughly qualified, and, therefore, well-paid Commissioners. With respect to the proposition of the Bill that opposition should be upon open documents, he believed every patent agent who was consulted at the time of the 1879 Bill, pointed out that if it were wished to encourage fraud, or to oppress an inventor with a law suit at the outset, the proposition of an opposition upon open documents was about the very best means of attaining these ends. The Bill proposed to leave to the law-officer the determining who was to be entitled to oppose; he did not see why this should be so. Why should not the Government Bill do as had been done by the Society of Arts' Bill, determine once for all who should be entitled to oppose? Why should anyone be allowed to oppose except on the ground that the applicant had taken the invention from him? Was it to be said that somebody was entitled to oppose because he had a manufacture going on to which the sought-for patent was applicable. If this manufacture had been going on in public, the patent was not worth anything. No one should be allowed to oppose a patent except upon the ground that someone was taking from him his invention, and he could not see any reason for the provision which had been made in the Bill, except the remains of the old feeling, that a patentee was a man to be discouraged, and, therefore, you were doing a good thing when you allowed anyone to get up and say I object to the patent. As regards the patents having effect against the Crown, he knew that Mr. Preece would give many reasons against this proposition; but he would ask them to listen to the statements which Mr. Preece would put forward as reasons

why such a clause should not be inserted in the Bill, and accept them as he accepted them, as reasons why the clause should be introduced; and as he would not have an opportunity of speaking after Mr. Preece, he must forestall that gentleman, and tell them what Mr. Preece's statements would be. Shortly stated, they were these—that such a provision was not needed, because voluntarily the Post-office paid an enormous sum for royalties every year to patentees; no doubt this was so, and as long as the management of the Post-office was in the hands of upright gentlemen, these royalties would continue to be paid. And he asked them to say that this showed the present Post-office authorities admired the payment of royalties as a fit and proper thing; this being so, was not that a strong argument for urging that the Bill should be altered, to insure that, whoever might be the authorities for the time being, and whatever might be the administration, patentees should be paid for their inventions when used by the Government. In 1879, Sir John Holker's Bill provided for this, and he had hoped that when once a Bill introduced by an Attorney-General had contained such a provision, that it would not have been thought well in any future Government Bill to withdraw it. He was sorry to say it had been withdrawn. It was inevitable that if persons were not to have the ordinary chances of reward from their inventions when used by a Government department, they would cease to care to make them. There was—and, unhappily, as he thought—a growing tendency for governing bodies to become traders. The Government were traders in telegraphs, and Corporations and Local Boards were traders in gas, and were owners of tramways. But if Government, or governing bodies became traders then provision ought to be inserted in the Bill making them amenable to the Patent-laws. To show to what the exemption of the Government from paying royalties might lead, he wished to mention that when the Electric Lighting Bill was before the House of Commons, a Town Clerk, representing an important city, suggested to the committee that patents ought to have no effect against Corporations, when Corporations were using improvements in the electric light; and that was a natural sequence, for if a patent was to have no effect against the Government, it was naturally thought it should have no effect against a Corporation, but if not against a Corporation, why should it have effect against any large limited company. With respect to the term of 14 years, he noticed that had been put in italics in the Bill, and that therefore it was intended to consider the question in committee. There would be an enormous convenience if the term in England were made the same as that in America. At the present time the result of there being a difference of term in the two countries was this, that if an Englishman or an American had an English patent for 14 years, the American patent, instead of existing for the 17 years, expired at the end of the 14 years. He knew that this expiry of an American patent with the expiry of a foreign patent was one of the points upon which Americans were very much dissatisfied, and with respect to which they wished to have a change made in the law. But until that change was made, it really was desirable, in the interest of both English and Americans, that the terms should agree. The next point in the Bill, which he noticed, was the provision that the law officer and the Privy Council might do a variety of things, such as extending the patent, or allowing amendments, coupled with conditions. As regards amendments, that was a most monstrous proposition. A man ought to get his amendment as a matter of right, and not as a matter of grace or favour; if he had made a mistake in his patent, he ought to be allowed to amend it without having to pay a large amount in the shape of costs, and without having to submit to an onerous condition. The result of this provision was, that a patentee who went to the law-officer to have his patent amended by disclaimer, was to be regarded as a humble suppliant for grace and favour, and, if he received it, might find it coupled with any condition that the law-officer might choose to put upon it, instead of getting it as a matter of right. That power of imposing conditions applied also in the case of extensions, and, at the present time, this power was exercised in a way to diminish the full scope of a patent. It was only the other day that a well-known firm of ship-builders applied for a prolongation of a patent for a screw propeller, and the extension was granted, but coupled with the condition that no royalties should be paid by any contractors who worked for the Government. That condition was an uncommonly hard one upon the inventor, it might take away his principal source of revenue from his patent, and, so far from encouraging the Privy Council to persevere in such a course, as the present Bill of the Government does, it should have taken away all power to impose conditions at all. An extended patent should have precisely the same scope as the patent had at the outset. Reverting to the question of examinations.—A very desirable proposition had been made in the Society of Arts' Patent Bill that there should be an ultimate power to a patentee to have his patent, notwithstanding any adverse report. No one was infallible; a wrong decision might be given by any law-officer or examiner, and it would be well, although it would probably not be needed in one case in a thousand, if a patentee, who insisted upon having his patent, were allowed to have it, notwithstanding the adverse report, provided in the event of his going to law upon the patent he gave security for the costs. He had stated at the outset of his remarks that a patentee did not receive the full benefit arising from the system of examinations; he was alluding to his position as plaintiff in a patent action. By the Bill the only alteration in the pleas that might be put forward by a defendant was the inability to plead that there was no license given for the disclaimer,

with this exception, he was allowed to plead any plea that he could plead at the present time. Although it would be unreasonable to ask the Government to give an indefeasible patent, there were some points which could just as well be determined at the outset as at any future time, and being once determined, there was no reason why the patentee should not have the benefit of that determination. He alluded more especially, in making this remark, to the question of "subject-matter." At present you could go to the law officer of the Crown, who had to say "Aye" or "No" is this subject-matter. Perhaps he said "Yes," and afterwards the patentee had to bring an action upon his patent, when the defendant pleaded it was not subject-matter. That went before the Judge, and he decided perhaps that it was not subject-matter. The law officer's judgment should be final, and another person ought not to be allowed to plead that this officer was so incompetent that he did not know what was and what was not subject-matter. Again, as to whether the patent as granted was that which was in the inventor's mind when he applied for it, as evidenced by the agreeement between the provisional and the final specifications, this ought to be determined once for all, and a person ought not to be allowed to raise as a defence to an action that the patent did not agree with the provisional specification. On those two points the patentee was entitled to have a decision at once. Then there was a point which the Bill took no cognisance, and that is, when there were two claims in a patent—if such a thing indeed could be under the present Bill—a man might be charged with infringing claim No. 1, and he replied, "Yes, I have done so, but claim No. 2 is bad." It was very hard upon a man when one claim had been infringed to find himself threatened with the loss of his action because another was bad. He did not see why this should be allowed to continue, it was contrary to French law, and was contrary to American practice. There was one proposition not in the Bill which he certainly had not expected to see there, and that was that a printed document, thirty years old, which had never been acted upon, should cease to be a publication for the purpose of invalidating an invention. If the Government desired to make a perfect Bill, they would insert that, although, no doubt, an unusual and an unheard of clause. When he was in the United States, he had propounded to many persons with whom he conversed upon this subject, this proposition, and he only met with one man who objected to it upon reflection; and he was glad to know that such a proposition met with the approval of their learned chairman of this evening.

Mr. W. H. Preece, F.R.S., said he had been somewhat anticipated in the remarks he wished to make by Sir Frederick Bramwell, though he was afraid that Sir Frederick had put a wrong construction upon what he intended to say. There was little or nothing in the Bill before them with which he had to find fault, though there was something in the paper read by Mr. Wood with which he intended to find serious fault. There was no more difficult thing in this world to eradicate than a well-established popular delusion, and the higher the intelligence, and the higher the position of those minds in which a popular delusion was fixed, the greater, apparently, was the difficulty of eradicating it. Mr. Wood had alluded to the fact that inventions were rather checked by the existing monopoly of the Crown, with regard to the establishment of inventions in this country, and he instanced one of the popular delusions, which was, that the Crown had a monopoly in telegraphic apparatus. He might state deliberately that the Crown had no more monopoly in the invention of electric telegraphs than it had in the use of mail carts or red coats. The telegraphs of this country were open to everybody. The telegraph service of this country, which was manipulated by the Post-office, was simply a flea-bite in the use of apparatus for telegraphic purposes, for of the 60,000 instruments at present in use, only about one-fifth were in the hands of the Government. In England, there were some ten or twelve telegraph companies, as well as innumerable railway companies, to whom inventors could go with their inventions, and to say that the Post-office or the Crown had a monopoly in telegraphic apparatus was absolutely erroneous. What they had a monopoly in, was quite a different thing, namely, in the transmission of letters and messages for which money was paid. It was quite true that according to the legal reading of the Patent-laws, there were certain rights of the Crown, which, under certain circumstances, must be exercised; but speaking from his own experience, and from the experience of the Post-office, he could positively say that these rights were never exercised. It was one of his unfortunate duties to have to investigate the claims and merits of inventions, and the number which came before him was usually two every day of the year. There had never yet been a single invention, however poor its author, brought before the Post-office which had not been carefully considered, nor had there ever been an improvement of merit which was not adopted, and if adopted, paid for. At the present moment the Post-office was one of the largest payers of royalties in the country for patents. In the Bill of 1879, which was produced by Sir John Holker, it was proposed to insert a clause placing Government departments in the same position as private individuals, but in the present Act this clause had been omitted for a very good reason, that if an invention was favourably considered, the inventor was sure to open his mouth to the Government about 100 times wider than he would to a commercial concern. The result was that it was thought advisable to keep some kind of control over these wide-mouthed inventors. Some of the demands made upon the Government in respect of inventions were simply outrageous, but provision was made in the present Bill for breaking through this kind of thing by providing

that all patentees should grant licenses under compulsory powers, to be exercised and controlled by the Board of Trade or some other body. Considering the insertion of this particular clause, and the fact that the Government did not, except with warlike material, exercise its Crown rights, he did not see upon what ground inventors complained of the omission of this particular clause. He had looked with a good deal of favour upon the introduction of this particular Act, as it facilitated and simplified to a very great extent the obtaining of patents, especially by the working classes. Moreover, it did a great deal to bring a patent within the reach of persons with a moderate purse, and it also brought the law of England more in accord with the law of America. Speakers were very fond of drawing a comparison between the English and American Patent-laws. It has often been stated that inventions are so prolific in the United States, because their Patent-laws are so good; but he thought that the law was a consequence of the popular feeling, rather than the cause of any peculiar inventive faculty in that country. The way in which inventors were treated in America was very different to that in which they were treated in this country. In America, if a man brought forward an invention, it was immediately looked at and considered, and perhaps accepted, but in England the inventor was looked upon as a man to be avoided. This state of affairs, he was happy to say, was now being altered, owing to the manner in which the question had been taken up and discussed by the Society of Arts and in other places, and owing to the fact that within the last few years new and startling inventions had been brought to the door of everybody, such, for instance, as the telephone and electric lighting. The result of all this was that an inventor was now being looked upon as a person to be taken by the hand. He thought that the proposed Bill was a great improvement upon all previous Acts, and he hoped that it would pass, and be found to be a boon to inventors.

Sir WILLIAM SIEMENS, F.R.S., said, although he had given a great deal of attention to the question of Patent-law for many years, he had not studied the present Bill with the care he should have liked to give it. Still he had gathered the points of difference between the Government Bill, and that proposed by the Society, and was disposed to agree with most of the observations of Sir Frederick Bramwell. The question of making it easy for poor inventors to get a patent was one which most people were agreed on, and he could not well understand how the Board of Trade could bring forward a Bill which, though it possessed many advantages, would still make it very difficult and costly for a poor inventor to obtain protection. Such a man had not the means of ascertaining all that had gone before him, and he had not that logical mind which would enable a man of more liberal education to at once formulate his invention so as to give a distinct idea of what he intended to claim. He should himself find it impossible to frame a claim such as would stand examination in a court of law, in making a first application for a patent. It took at least four or five months of study and experiment to give an inventor's conception that definite form which was necessary before he could prepare a claim. In that respect, therefore, he hoped the Bill would be amended. Besides that, it was proposed that this precisely formulated invention was to be laid open to the public, to be scrutinised, amongst others, by manufacturers who might be desirous of availing themselves of the inventor's ideas, without considering his rights; and thus the inventor had to run the gauntlet of a kind of law suit at the first start, in order to substantiate his application, which would again be a great hardship on a poor man. Then came the question of the officers appointed to examine the application, and report to their superior, with an appeal to the law-officer, and this organisation appeared to him to be insufficient. He thought the law-officers were perhaps the best judges on any legal point which might arise, but it would be impossible for them to attend to the duties of a Patent Commissioner. If the examination was simply into the form of application, to see whether it was consistent with the rules, it might be sufficient, but this examination would be of very little value. In his opinion, the examination should certainly comprise the question of novelty. It did not follow that the office should have power to refuse an application, but it ought to assume the position of an honest dealer. If a person came before it to-day, and asked for a patent, and a fortnight later, another man came with a similar application, was the examiner to say, this is a good application, as far as form goes; exactly the same thing was applied for a fortnight ago, but that is not my business, and therefore you may pay your money, and get your patent, though afterwards you may find out that the same patent has been granted twice over? He called that dishonest dealing. Surely the office should say this application cannot be of any use, because the same thing has been granted before. If the application were referred back to the applicant, he would see probably that, notwithstanding the previous patent, there might be something new in his idea, and it would be quite possible that he would, after some consideration, make a very good application for a patent. It might be said that the inventor had his patent agent to go to; but how was it possible for a patent agent to examine the whole of the patent records? He would, no doubt, advise his client to the best of his judgment, but a search throughout the documentary evidence in the Patent-office would be entirely beyond his power. On the other hand, the patent examiner, who would probably take one branch of applied science, would have it at his fingers' ends, would know by heart what had been done, and could say at once, "Your application

interferes with so-and-so; examine these, and then come here again." In this respect he approved of the German Patent-law. He had taken a good many patents under that law, and had found it a great advantage to be advised, as it were, by the Patent Commissioners. The result had been that his patents had been more judiciously worded than would otherwise have been the case. Perhaps rights were claimed which would be rather objected to in this country, because, after an appeal to the Chief Commissioner, a patent could be absolutely refused on the ground of want of novelty; but instead of that, they might adopt the suggestion which was thrown out by Sir Frederick Bramwell, that if anybody insisted on having a patent after being informed of what was before him, it should be granted, with a statement of the advice received from the Patent Commissioner. That would be a guarantee against a person insisting on a patent for unfair purposes, and he would not run any risk of being unfairly dealt with. Next came the question which had been already argued, whether the Government should be exempt from the operation of the Patent-law; and on that point, it appeared to him, that Mr. Preece had drifted into certain inconsistencies. He said that his department had always been most ready to reward inventors. He must say that he had not heard of great rewards being paid to outside inventors by any Government department; but supposing the Post-office had been so generously minded, notwithstanding the difficulty which Mr. Preece mentioned, of getting the Treasury to fall in with their liberal views, would it not be better for the inventor, if he could go before Mr. Preece, not as a petitioner, asking a reward, but with some right to stand upon. Mr. Preece's idea seemed to be that he should come, hat in hand, and say, here is an invention of mine, I beg of you to give me something for it. That was not a position which he for one would care to assume. The other proposition which Mr. Preece approved of, and which he had always advocated, was that of compulsory licenses. He remembered the time when he was blamed by the advocates of patent rights for pressing it, but he considered it was fair all round. A patentee was not a monopolist; he was the holder of a public trust, and ought to administer the trust fairly, and if he would not, he should be compelled. The Government might take full advantage of this right. If a patentee made exorbitant claims, he would be simply told that his claims would be inquired into, and whatever was his due he would receive and nothing more. Mr. Preece said the Post-office exercised no monopoly, but in that he could not follow him. If you wanted to make a private line of telegraph on your own estate you could do so, but you could not communicate with the outer world. You might communicate from your house to your stables. but the moment you wished to communicate with the nearest telegraph station, you would be told to pull down your own line, and to go to the Post-office to get a new one made. Everything must be done by the Post-office. That might be quite consistent from a Government point of view, but it made a gross monopoly, and the only people exempt from it were companies or persons who put up lines on their own property. A man with an estate of a square mile might put up a telegraph on it, and a railway with a line 100 miles long might put a telegraph along that railway, but there they must stop. Telegraphy ought to go from one end of the country to the other, and not be stopped by any such boundaries. If patentees had a chance at the Post-office at present, it was merely by favour, and not by right, as he should like to see it.

Mr. R. W. WALLACE was somewhat surprised at hearing Sir William Siemens's remarks, in advocating an examination as to novelty, as he had always understood that one of the reasons why such a provision did not exist either in the Society's or in the Government Bill, was that England had gained so much while Germany had suffered, especially in the case of Sir William Siemens's own inventions, by the emigration of inventive talent from that country to this, on account of that provision. Still it was worthy of consideration whether some clause should not be introduced by which the titles and numbers of patents, which seemed to be infringed upon, should not be endorsed upon a patent, so that the public at least should not be taken unawares. He thought compulsory licenses would be advantageous in many cases, but, on the other hand, such a system might lead inventors to keep their processes secret instead of publishing them, which would be a serious public disadvantage. In the event of patentees refusing to manufacture in this country, a system of compulsory licenses would no doubt be of great benefit. He should like to hear something more from legal gentlemen as to the constitution of the tribunal. It might be difficult to appoint a special court, consisting of a Judge and assessors, to try patent cases, and yet a good deal might be said in favour of such a plan. For example, in the trial of chemical cases, the Judge had nearly always to be instructed by the counsel on the chemistry of the case under investigation, and as these cases were often similar, a Judge who devoted his attention entirely to such causes would become acquainted with chemical and scientific matters, and thus there would be a great saving of time and expense; a result which is obtained in the trial of shipping causes by the similarly constituted Court of Admiralty.

Mr. MORGAN thought it would be far better to have a lawyer, assisted by assessors, rather than to have a chemist or a scientific man at the head of the Patent-office. He thought the definition of subject-matter in the Society of Arts' Bill was far preferable to the one in the Bill now before the House. The point of provisional protection had been pretty well thrashed out, and he would not say anything more

upon it; but with respect to the fees, it seemed not to have been noticed that though you got protection for £4, at the end of four years you had to pay the heavy charge of £50. He would suggest that the Society's Bill should be taken as the basis, that £20 should be paid at the end of the fourth year, with two further instalments of £40 each, and that the term should be extended to 17 or 21 years.

Mr. ALFRED CARPMAEL said he differed very seriously from the Chairman of the Council in one respect. He thought after full inquiry they had satisfied themselves that it was not desirable to have an inquiry into novelty; and if there was one point more than another on which he agreed with what fell from the President of the Board of Trade, it was on this subject. Mr. Chamberlain had said that he also was at one time impressed with the desirability of making an inquiry into novelty, but after full investigation he had come to the conclusion that if there was to be an inquiry at all, it must be thorough; and that the expense of a thorough inquiry in every case, whereas it might only be wanted once in a hundred, would impose on the poor inventor a burden which he shrank from. It seemed to him that the arguments were entirely against an inquiry into novelty at this stage. With regard to Mr. Preece's observations, he said the Post-office had not any rights, and if it had, it did not use them; but he believed there was not a patent agent who would not say, when an inventor came to him with an invention for telegraphing, "Is it a printing instrument?" And if he said, "No," he would at once advise him to go home and have nothing to do with it. But assuming it were not so with the Post-office, it was with other Government departments. Sir Frederick Bramwell had alluded to a recent case in the Privy Council, where a condition was imposed on the renewal of a patent for a propeller, that no one who used it for a Government contract should be obliged to pay royalty. The condition had been imposed in another case, and in the propeller case it had been declared to be the rule of the Privy Council, and it would be perpetuated if the Bill passed. What struck him most in Mr. Preece's speech was the remark that Government had such exorbitant demands made, that they thought they ought to have some control. Being the head of a somewhat numerous family, he thought he ought to have some control over the butchers' and bakers' bills, as to the prices they should charge; but, unfortunately, they took a different view; and if inventors were consulted, they might not agree with Mr. Preece as to the absolute necessity of the Government fixing their own price for what they took. He would now, considering the lateness of the hour, only point out the enormous amount of work which this Bill would throw on the Comptroller. They had heard that Mr. Preece had two inventions a day brought before him, but, as he reckoned, the Comptroller would have one every ten minutes. The President of the Board of Trade told the House he estimated that the applications under the new Bill would increase 50 per cent., but if the provision were insisted on, which limited a patent to one invention, and it were made to follow the American practice in that respect, that alone would give an increase of 50 per cent.; and as the cost of an application was to be reduced, he thought it might be safely reckoned that the future applications would be three times as numerous as the present, which would give the Comptroller one for every ten minutes of his official life, to say nothing of applications for specifications, appeals, and amendments, besides which he would have designs and trade marks on his shoulders as well. He cordially agreed with all that had been said in Mr. Wood's paper, except the last paragraph, and as to that, though he did not wish to disclaim any responsibility as to the opinion attributed to himself, or for any suggestions he had offered, he disclaimed all credit of preparing the paper, and declared that the whole of its artistic merit was due to Mr. Wood alone.

Mr. JAMES WATSON observed that the examiners and Comptroller's duties could not be clearly gathered from the Bill. No one had yet suggested the doing away with the preliminary examinations altogether, and making the functions of the examiners purely ministerial, allowing anyone who chose to come for a patent to have it at his own risk. If a preliminary examination were instituted, it should be exhaustive; anything short of that would only lead to wrangling and expense, and the experience of other countries was not favourable to examiners. He believed Sir William Siemens himself had been a victim to the German system.

Sir WILLIAM SIEMENS said that was under the former law—not the present.

Mr. WATSON said there was also a great deal of wrangling and expense under the American system. Considering what had just been said about the number of applications likely to be made, it was a strong argument against preliminary examinations, and in favour of letting any applicant take his patent at his own risk. He did not see how examiners could very well examine into subject-matter without including the question of novelty, unless the system were adopted, as in Germany and France, of having lists of certain things, which were not patentable. He agreed with the criticisms on the provisional specification, and thought it would be better to abolish it altogether. He did not think the Bill went far enough in reducing the fees.

Mr. H. TRUEMAN WOOD said he hardly felt that he had any right to a reply, his paper having been only brought forward with a view of eliciting discussion, and from that point of view, he was glad to be able to say that it had been highly successful.

He was not prepared to dispute Mr. Preece's statements, and on matters of fact, of course, they would all accept what he said; but if Mr. Preece had met one of his objections, he had supplied a far stronger one. If the Government did not want to use the power of using inventions without paying for them, why should it be retained? If they really meant that they could not make a proper bargain with an inventor unless they had this threat in the back ground, and could say to him—unless you will sell your invention at a cheaper rate than we have any right to buy it from you we will steal it, the less said about it the better. One point had struck him very forcibly throughout the discussion, and that was that most of the objections raised to the Government Bill were really met by the Bill which Sir John Lubbock had introduced on behalf of the Society. On the question of "racing for the seal," mentioned by Mr. Reddie last week, and by Mr. Boult that evening, there was a doubt in the Government Bill, but in the Society's Bill it was perfectly clear. The same with regard to the point mentioned by Mr. Houghton as to an inventor being unjustly deprived of his rights by fraudulent anticipation, which was met by Clause 36 of the Society's Bill. He mentioned these two because they were raised by gentlemen who had had no hand in framing the Society's Bill. He would conclude by expressing his gratification that there had been so little to find fault with in the remarks he had made upon the Government Bill.

The CHAIRMAN then proposed a vote of thanks to Mr. Wood for his paper. He was very glad to say that the discussion had not been by any means barren of results, for it would be found, on a perusal of the parliamentary papers, that amendments had been already put down which were founded on some of the recommendations made last Wednesday. It was unnecessary to say anything further on the majority of the points which had been discussed, and he trusted that what he had ventured to point out as unworkable, viz., the claim at the end of the provisional specification, coupled as it was with the clause that only one invention could be claimed, with the further provision that you might disclaim part of an invention, would be withdrawn or amended. The same observation applied to the opposition upon open documents, which, in justice to inventors, ought to be materially altered, so as to be more in accordance with the present well-tried practice. As far as he could judge, the objectionable provision, that the taking out of foreign letters patent should limit the terms of English letters patent, was altered by the Government Bill, because it depended on a provision of the Act of 1852, which was wholly repealed. Something had been said as to the possibility of there being a slight deficiency with reference to the expenses of the future Patent-office and the fees likely to come in; he could only say he did not believe there would be any deficiency at all; but be that as it might he hoped that those who had to deal with this matter would protest against a surplus which came from the fees of inventors being devoted to general purposes. At least they had a right, if it was said this is going to cost the country ten, fifteen, or twenty thousand pounds during the next four or five years, to call attention to the fact that the country has had the benefit of hundreds of thousands out of inventions in years gone by. He must say a word with regard to the remarks of his friend, Mr. Preece. There was a simplicity about his argument which was quite refreshing, and he wanted no better argument for the views which he had put forward than Mr. Preece's own. That gentlemen said there was nothing to fear; that there never was an invention which was not carefully considered, and adopted if it were good, and never one which was not paid for liberally. Well, that was all they wanted. What they protested against, and it was by no means an illusion raised up by patentees for the sake of creating a grievance, was the idea which had been maintained by the Government that patents did not bind the Crown. Mr. Preece said very fairly that the Government did not want to take advantage of any man's brains without paying for it; then let them say, once for all, that the Crown should not have the benefit of an invention without paying fairly for it. As had been pointed out by Mr. Wood, and others, the clause as to compulsory licenses met every possible objection to an inventor being a dog in the manger, when it was for the interest of the country that his invention should be used. He had been much surprised to hear a gentleman, whose practical experience as an inventor was second to none, suggest that which he thought they had all agreed could not be adopted, viz., an examination as to novelty. He was quite certain inventors in England did not wish it, and that they would be very sorry indeed if there were to be an expensive inquiry, which might damage their title. Most of them thought, and in many cases rightly, that they knew more about the novelty of an invention than anybody else who merely referred to indexes and a mass of documents, as to which he had no practical knowlege as to what their real bearing might be. If there were an examination into sufficiency of specification and good subject-matter, it was quite enough. Sir Frederick Bramwell had referred to the question as to whether good inventions should be invalidated by old knowledge some thirty years before, and he was glad to find he agreed with him, but he would suggest that they had so much else to fight for, that it would be better not, unless the atmosphere were very favourable, to raise that contention at present. He hoped that, if necessary, there would be an amendment Bill, going a little farther, in a year or two, and they had better be satisfied to take out of the present Bill, if they could, those blots which were radical, and to put in those amendments which were based on sound practical know-

ledge and experience. The discussion had been to him most useful and interesting, and he thought it would be valuable to all who heard it. It had accentuated the points for which they ought to strive, and had also recognised in a fair and liberal spirit that which more than one speaker had referred to, that whatever the blots in the present Bill might be, and however they might think it had been prepared by persons who did not possess strictly practical knowledge, still it was an honest attempt to do something for the inventor of this country—for those who were advancing its trade and prosperity by inventions which were for the good of mankind, as much as for the inventors themselves.

The vote of thanks was carried unanimously, and the proceedings terminated.

The following letters from Mr. Newton, Mr. Ibbotson, and Mr. Tweddell, have been received since the reading of Mr. Wood's paper on the 18th instant:—

The Government Bill purports to alter the law in favour of the poor inventor, and the evident intention indicated both by the reduction in the first cost of the patent, and the simplification of procedure, was fully appreciated in the discussion of Wednesday evening last. I am inclined, however, to think that a more careful consideration of the Bill will show that the advantage to the inventor will be small, while the additional technical labour occasioned will increase the necessity for the services of the patent agent; it may, in fact, be rightly termed, a patent agents' Bill, although there are unmistakeable evidences to show that it is directed against that profession.

The reduction of the primary fees on patents to £4, will have the effect of greatly increasing the number of applicants for patents, and the facilities afforded by the Post-offices to bring the applicants and the Patent-office officials into communication, will still further encourage resort to the Patent-office. But here the advantage to inventors ends. The net has been spread for them, and they are, we will say, caught in shoals; but what is to become of them when hauled in? Have the authors of the Government Bill any notion of the difficulties and perplexities which they are creating for inventors? The Patent-office officials receiving by post, or directly from inventors, papers which will, in the main, be unintelligible to any but the writers, will not be able, by any amount of correspondence, to impart their notions of what form the applications should take, and out of sheer necessity they will be obliged to advise inventors to call in the assistance of experts. The patent agent, after an examination of the papers and the correspondence, will either suggest a withdrawal of the application, or will, if the date is of importance, at infinite pains create order out of chaos, and produce an acceptable provisional specification.

If, however, the inventor's provisional specification is accepted by the office, the *crux* will come on the complete specification, and here the difficulty will be increased tenfold, for it would be simply hopeless for the officials to attempt to instruct the inexperienced inventor as to the legal requirements of a complete specification, much less to furnish him with the power of carrying out the imparted instructions. At this stage, therefore, the patent agent must certainly be called in, who would commence his work with the disadvantage of having to fit a complete specification to a provisional which has, perhaps, barely served to pass the examination of the officials, and may well be supposed to be wanting in every needful particular but form. The probability will be that the patent agent, finding his task an impracticable one, will advise, in the case of a valuable invention, that the application be abandoned. The result of this will be, not merely the loss of the £4 Government fees, but the loss of more than nine months in respect of the ultimate date of protection for the invention, besides the trouble which the inventor has incurred, and the useless labour of the patent agent. So much for simplification of procedure.

Supposing, however, that the services of the patent agent are secured at the outset; he will prepare the provisional specification as at present, but in addition to that labour he will have to consider what claims could, or should, be made for the invention. Instead of, as at present, satisfying himself that he knows sufficient of the nature of the invention to set it down in writing, he must master the details as fully as when preparing a complete specification; he must consider the possible uses to which the invention may be extended, and having formulated the claims which he thinks might be sustainable, he will have to consider what are the probabilities of those claims being evaded, and this at a period when the inventor, from want of experience, is utterly unable to assist him. Let me ask who is sufficient for this work, and if the man is to be found, what compensation may he not fairly claim for his labour?

When provisional protection is obtained, a complete specification will be required to be filed at the time of applying for the seal. The cost of preparing this document, at present, not infrequently exceeds the total fees on the patent grant. After this expenditure has been incurred (not without benefit to the patent agent), the inventor has to face the risk of a patent being refused him, for at this stage he may encounter opposition from rivals in the trade to which his invention relates, or he may be unable to satisfy the officials that his provisional and complete specifications are in accord, and, indeed, it may be impossible, with due regard to the production of a sufficient specification, to make the two documents accord. If the patent is refused on either of these grounds, the loss of the fees will form but a small proportion of the total disbursements of the inventor. Mr. Wood touches, in his paper, on the hardships to which the inventor is subjected by reason of the publicity of the details of his invention for which a patent has been refused, and that is an additional loss thrust upon him by this Bill.

Another, and more general drawback to the Bill, consists in the creation of contentious work, which must form a heavy item in the expenses of a patent; and it is here that the Bill steps in to assist what the *Times* calls "that clever, but somewhat too necessary and prominent class, patent agents."

At present they have to carry through oppositions to patents and to disclaimers, and of this work the Bill does not deprive them, but it gives them, in addition, the work of contesting with the officials, not merely the sufficiency of the provisional specification, but the sufficiency of the complete specification, which, if seriously contested, either on the ground of disagreement with the provisional, or of want of clearness of detail, may be equal, at least, to the labour of preparing the specification.

From these remarks, I think it will be seen that the prospect which the Bill holds out of cheap patents, is not altogether to be relied upon. If I could see that any good could possibly result to inventors from the introduction of this contentious

business, I should be silent on the point, notwithstanding my personal dislike to such work; but I am satisfied, from my experience of the action of the American and German systems (which the Bill proposes to import in a modified form), that only evil to inventors can result therefrom, the reduction of the fees serving rather to aggravate than to lessen the difficulties which the proposed examination must create. A. V. NEWTON.

Mr. ALFRED IBBOTSON writes, approving of the reduction of fees, but objecting to some other points in the Bill. Amongst these are the provisions as to the correspondence of provisional and final specifications, and the extension of the period of provisional protection (on the ground that other inventors are kept for an unreasonably long time in ignorance of the invention). Mr. Ibbotson argues that the present system of commuications from abroad should be continued, and that there is no necessity for limiting applicants to the true and first inventors. He says that the suggestion has been made to him that if a patent is to be granted only for one invention there would be no difficulty in settling the claim in the provisional specification; but he answers that in that case there is no need for any provisional specification at all. The provisions for compulsory licenses he considers as equivalent to an Act compelling a successful man of business to take into partnership any person who might desire to share his prosperity. Mr. Ibbotson concludes by remarking that there is no provision enabling the representative of a deceased inventor, who may have died before getting protection, to get protection for the invention in question.

Mr. RALPH H. TWEDDELL writes:—There is some ground for fearing that inventors as a class are now suffering, like the police, from too much kindly flattery and sympathy. So far as the poor inventor is concerned, it is to be feared that if the Government Bill becomes law, his last state will be worse than the first. It is true he is only asked for £4 instead of £25 to commence with, but this small sum is to be paid for a provisional specification, which must be accompanied by a claim. It is unnecessary for me to say more in depreciation of this proposal than has been already stated by speakers in the discussion. I think it well to again repeat my own conviction that cheap patents will, in the long run, not really benefit working mean or other inventors, who either have not the means to pay the fees themselves, or sufficient interest to get others to do so for them.

The speculating capitalist will be in a position to take out any number of cheap patents, and mauufacturers who have capital invested in machinery, and who are by the sheer force of competition glad to take up good patents, will become nervous, and cease to take up new inventions if patented. There is an old fable, which runs as follows:—A controversy prevailed among the beasts of the field as to which of the animals deserved the most credit for producing the greatest number of whelps at a birth. They rushed clamouring into the presence of the lioness, and demanded of her the settlement of the dispute. "And you," they said, "how many sons have you at a birth?" The lioness laughed at them, and said, "Why, I have only one; but that one is altogether a thorough-bred lion." Moral: The value is in the worth, not in the number of patents. If the number of separate claims or inventions has to be limited as proposed, the total cost of patenting any system or series of operations of one class not capable of various modifications will be much greater than it is now.

There is nothing like taking time to consider changes affecting so many interests, and I may confess at once that I am now, after more reflection, prepared to support the principle of annual payments, and the suggestion made by Sir Frederick Bramwell, that, after a lapse of thirty years, any idea or suggestion proposed at that time, but not practically carried into effect, may be considered as a subject for a patent. I do think, however, that the name of this ancestral inventor, as it were, should, when known, appear in the description along with that of the patentee or inventor. As to duration of a patent, speaking with some experience, I should consider that 21 years is not at all too long a term, and certainly it should not be less than 17 years.

So far as examination, and the working staff of the Patent-office are concerned, I think Sir William Siemens must desire to confer the same benefit on some other country, by driving out inventors from England, as was conferred by Germany, in his case, on this country. I have all along maintained, so far as the Patent-office is concerned, that all that inventors require is a large and intelligent staff of "searchers," acting under a Board of Commissioners. An inventor has a right to have a patent granted to him, so written and drawn up, that it cannot be upset on any mere legal or technical quibble. More than that, I think it is useless to ask, and if we even obtain more, it would probably not be of much practical value. The final tribunal after all must be the High Court of Justice, and so far as Commissioners are concerned, I should say eighteen or twenty-four gentlemen, and those of considerable eminence, will be required. But after all, it is a question of money, and if half the ability and energy which has been expended on this question had been directed and brought to bear on the Treasury, I think that there exist all the necessary elements in the Act of 1852 (if liberally carried out) of a good patent-law, both for patentees and the public. I think the Bill under discussion savours too much of Governmental control and interference. It gives with one hand and takes away with the other. It will not, I believe, practically benefit the poorer class of inventors, and it is not required by others. If it were possible to engraft some of the proposals in the Society of Arts' Bill on to the Bill of 1852, and bring pressure to bear on the Government to carry the spirit of that Act into effect, then I think patentees would have some reason to congratulate themselves. I see no allusion to the improvement and establishment of museums, and it is evident that more real assistance would be given to an inventor on the look-out for any anticipations of his invention, by means of good libraries and museums in London and in the principal manufacturing centres, than by any such unworkable scheme as that now proposed in the shape of examiners. I for one would certainly prefer to risk any responsibilities on a patent on my own judgment and that of my patent agent.

Miscellaneous.

ECONOMIC BOTANY AT KEW.

(Continued from p. 571.)

HEVEA.—*Ceylon.*—Dr. Trimen reports:—"A single tree of Hevea flowered at Heneratgoda, and produced a few capsules in April. The growth of Para rubber is not rapid; our largest is now 21 inches in circumference at a yard from the ground, an

increase of 5 inches in the year. New plantations of Hevea have been formed, and some trees at Peradeniya have been planted in a position in the new garden, where they are flooded when the river is high, with a view to an imitation of their native habitat."

Madras.—Mr. Cross writes, March 6, 1881:—"The Para rubber has seemingly not found its proper habitat at Nilambur. The young plants have shot up like long whip-handles, with a bunch of leaves on the top. There is not, however, the slightest reason to despair of success."

LIBERIAN COFFEE.—*Dominica.*—Dr. Nicholls writes, September 27, 1881:—"My Liberian coffee plantation is getting on capitally, and the old trees are loaded with berries. The first flowering commenced this year on February 25th, and lasted for several days; and the second flowering, which also lasted for several days, began on April 18th. Since then I have noticed several trees bearing flowers on the following dates—May 23rd, August 5th, August 10th, and September 5th and 10th. I find that the branches of *C. liberica* have a different habit from those of *C. arabica*, for, whilst the branches of the latter trees are pendulous, most of those of *C. liberica* have an upward tendency, and the younger primary branches make a very acute angle with the stem. I have been experimenting in topping the trees, but only with partial success, in consequence of this erect habit of growth. When a tree is topped, secondary buds form below the last pair of auxiliary branches, and very shortly they will develop into upright stems. If these be removed, the last pair of auxiliary branches frequently take an upward direction, and in time form a bifurcated continuance of the main stem. These interesting facts point to the inadvisibility of trying to dwarf the trees, and they show that the trees themselves struggle to overcome the interference with their natural mode of growth." Dr. Nicholls has published (S. W. Silver and Co.) a useful little work "On the Cultivation of Liberian Coffee in the West Indies," in which he has embodied the results of the observations of the late Dr. Imray and himself. The progress which the new staple has made, owes everything to the exertions of these gentlemen. The plant was introduced into Dominica in 1874, from the Royal Gardens, Kew. At the present time large supplies of berries, for seed purposes, are exported from Dominica to Martinique, Guadeloupe, Jamaica, St. Kitts, and Trinidad.

Jamaica. — The Government has published a pamphlet by Mr. Morris, entitled "Notes on Liberian Coffee: its history and cultivation," which gives an elaborate account of everything known about the plant.

Nilgiris.—I extract the following from the report of Mr. Jamieson, superintendent, Government Botanic Gardens, dated October 25, 1880, but which has only recently come into my hands:—"I consider the progress made, and the present condition of the plants eminently satisfactory, and it is now beyond doubt that this variety of coffee, when grown under conditions analogous to those at Barliyár, is vastly superior to the ordinary *Coffea arabica*. Another interesting fact with regard to this coffee has been determined during the past year. Having had opportunities of examining the flowers and fruit of the plants introduced and planted at Barliyár, in 1877, as true 'Liberian coffee,' I am now quite satisfied that it is a distinct variety from the plants received in 1874-75, as 'West African coffee.' There is no distinguishable difference between the leaves and habit of growth of the two varieties. The flowers of the West African are not so large, and the berries are borne in larger whorls, and are more spherical in shape than that of the true Liberian variety; but the most important difference, in a commercial point of view, is that the West African is a much freer and more abundant cropper than the other; it is also hardier, and ripens its fruit about two months earlier than the latter, and it has never produced any abortive berries, which is frequently the case with the Liberian variety. Several hundred seeds were sold, and 5,625 plants raised from last year's crop of West African coffee, and orders have been received for 500 plants. With a view to encourage planters to take up the cultivation of this valuable coffee in suitable localities, I intend advertising plants for sale at greatly reduced prices. Our trees have not been topped or pruned, but allowed to grow in their natural form, and promise to yield a good crop this year; but no doubt the yield of fruit will be greatly increased as more care and knowledge are brought to bear on their cultivation."

Queensland.—Mr. James Pink, Curator of the Brisbane Botanic Gardens, writes October 10, 1881:—"Queensland grown coffee is being sold in the Brisbane market this year for the first time; the green berry at 8d. per pound. We are also raising large quantities of Liberian coffee from seeds, sent from Ceylon. It is doubtful whether it will succeed near Brisbane, but it will doubtless thrive well further North."

Seychelles.—Mr. Cockburn Stewart, Civil Commissioner of the Seychelles, writes May 22, 1881:—"You will be interested to hear that the Liberian coffee, which was sent originally to Mauritius by you, in 1877 or 1878, has succeeded here in a marvellous manner. The soil and climate of these islands appear to be just what is required for the cultivation of Liberian coffee. Cacao planting is beginning to make great progress here, and it is impossible to imagine anything finer than the produce of this tree in Seychelles. Vanilla grows abundantly, and is of a magnificent kind. It is a pity that these islands are not better known in England, for they doubtless present a great field, and will in a short time, if properly managed, become one of the most important spice producing countries in the east. There is no money in the place, unfortunately, and it is by far behind hand; but I feel convinced that a great future is in store for Seychelles."

INDIAN BOXWOOD.—Considering the scarcity of boxwood, and the continuous demand—a scarcity that has existed for some time, and a demand that is constantly increasing—anything connected with new sources of supply is naturally of much importance. Sir Joseph Hooker says, under the head of Indian boxwood:—The possible supply of this commodity from India was adverted to in the Kew Report of 1877, page 27. Messrs. Joseph Gardner and Sons, the well-known timber merchants, wrote to Dr. Brandis, the Inspector-General of Forests in India, April 29, 1881, on the subject:—"We bought the parcel (about five tons), landed ex. *Strathmore* in London, at the high price of £30 per ton. At these high prices the consumption will be very limited indeed. Can you kindly inform us what the prospects are of securing any large quantities of this wood—say, 5,000 to 10,000 tons—at about £10 per ton in Liverpool or London? We are drawing our present supplies from Russia and Persia principally; but there are so many restrictions, and the wood is also inferior to your English shipments, that we should prefer drawing all our supplies from India. At anything like £30 per ton only very small quantities can be used; at £10, however, it would probably be used very extensively for various purposes for which cheaper woods than boxwood are now used."

To this communication Dr. Brandis replied, July 6:—"The boxwood resources of the country are very limited. . . . There is no chance of such large supplies as from 5,000 to 10,000 tons being available from India."

It is evident, therefore, that we cannot look to India to remedy the increasing dearth of boxwood. It would be obviously much to the advantage of any of our colonies that could send into the timber trade any wood which would be acceptable as a boxwood substitute. Ten pounds a ton is considered by the Indian forester to equal about four shillings the cubic foot. A further consideration is that the expense of conveying boxwood from the forests in India is very great, and unless a high price were reached, its exportation would be impossible. The logs composing the parcel already referred to had to be carried partly on men's backs, and partly by carts, from the forests to Saharunpur, and thence by rail to Bombay. A price of £30 per ton gave a profit of about 3 per cent.; £17 10s. was consumed in expenses, and any price which did not cover this would of course involve loss.

A great deal has been said on the subject of Cinchona cultivation in different parts of the world, and the progress of the most valuable varieties are recorded. On the subject of cocoa cultivation in Central America, the following extract from the "Transactions of the Massachusetts Horticultural Society" is given:—"The cacao trees grow about as large as a moderate-sized plum tree, and are exceedingly beautiful. They are raised in nurseries, and afterwards planted in orchards, and by the side of each a banana is set to shade the young cacao tree until it is five or six feet high. At intervals in the orchards is planted a tree called 'madre de cacao,' a species of *Erythrina*, or coral tree. It sheds its leaves towards the end of the dry season, and during the wet season flames out into crimson flowers resembling those of the gladiolus, and in such numbers as to completely cover the tree. It thus affords abundant shade during the whole year, and to give this shade to the cacao tree is the object of planting it. On the plantation of the Lacayo family, 'Las Malaccas,' the mother trees are old and more than 70 feet high, and in May, the first rainy month, are all in gorgeous blossom. When these trees are seen from an elevated position, mixed with the green of the banana, a cacao orchard affords a sight not merely of beauty but of wealth. The flower of the cacao tree are borne in bunches, and are of a delicate pinkish white. The trees are very infertile, producing only from twenty-five to thirty ounces of seed in a year."

From Madras, Mr. Jamieson reports:—"The cocoa trees continue to thrive, and yield remarkably well; orders have already been registered for upwards of 1,200 plants. I anticipate no difficulty in being able to dispose of the entire stock of plants at good prices before the end of the planting season."

Surinam.—Mr. Hensen states that, "in Surinam, the cocoa with yellow pods, called 'Creole coca,' is generally planted. Another sort, with red pods, named 'Caracas cocoa,' is also, at present, planted by everyone who can get the seeds. Where both are grown in the same field, the red degenerates before the Creole. Planters there assert that the Caracas grows more quickly and strongly, and that it bears more and better than the Creole. The beans are lighter than those of the Creole variety, so that, on on average, the kernels of ten to twelve Creole fruits will yield one-half kilogram (1·1 lbs.) of cocoa, while for the same quantity fourteen to sixteen fruits of Caracas are wanted. The Caracas has more spongy beans than the Creole, but the flavour of the former is superior."

The foregoing extracts will show the character of the work done at Kew, and these extracts refer to a few only of many facts connected with economic botany referred to in the report.

BOSTON EXHIBITION.

An Exhibition of Foreign Production is to be opened at Boston, Massachusetts, on September 1st next, under the auspices of the Massachusetts Charitable Mechanical Association (instituted in 1795). The following is the official statement respecting the proposed Exhibition:—

The Foreign Exhibition Association is a corporation organised under the General Laws of the Commonwealth of Massachusetts, U.S.A. Its charter is granted for the following purposes:—

"The general improvement of the manufacturing

and mechanical interests of the United States, by means of holding worthy and adequate exhibitions of foreign manufacturing, artistic and industrial productions; the improvement of educational facilities afforded to artisans; the providing of foreign libraries of reference, for use at such Exhibitions; the providing of lectures and discussions on subjects of industry, science and art; and the providing of all other proper means by which these objects can be accomplished."

The Association will hold an Exhibition consisting exclusively of foreign arts, products and manufactures in the City of Boston, to open September 1st, 1883, and continue open not less than three months. The advantages of such an Exhibition to foreign manufacturers, and others who may exhibit, must be apparent, while there can be no question as to the interest which it will awaken in the United States. This country has had no opportunity since the Centennial Exhibition, held over six years ago, to see the recent advances of foreign art and industry. The National Government of the United States has manifested its interest in the enterprise by legislation, which will greatly facilitate the work of all interested, and will especially lighten the expense to exhibitors.

The building in which the Exhibition will be held is centrally located, and of easy access from all parts of the city. It has been erected at an expense of over half-a-million dollars, and is constructed solely for exhibition purposes; it has every facility for the rapid and easy delivery of exhibits, and every possible convenience for visitors. It has electric lights in abundance, steam power, water, gas, and a large hall for holding public meetings. It is so arranged as to permit of the separate and distinct representation of every nation in a "court" or section set apart for its exclusive use. It has, in all, over seven acres of floor space.

By an Act of the Congress of the United States, approved by the President, June 28th, 1882, all goods intended for this Exhibition will be admitted to remain in bond free of duty while on exhibition. At its close they may be sold upon payment of the duty, under the approval of the government of the association.

There will be no charge for space. Blank forms of application and circulars giving all further particulars may be obtained from any United States Consul or Consular Agent, and Commissioners appointed by the Directors will visit the principal cities for the purpose of further facilitating the plans of exhibitors. It is important that application should be made at the earliest moment possible.

Medals and diplomas will be awarded to exhibitors. No sales of the articles exhibited will be allowed, except for delivery at the close of the Exhibition; but arrangements will be made by the Board of Directors for the sale of duplicates.

All correspondence should be addressed to Gen. C. B. Norton, Secretary Foreign Exhibition Association, Boston, Massachusetts, U.S.A. Copies of the regulations and forms of application for space can be obtained on application at the Society of Arts, John-street, Adelphi.

THE GERMAN CHICORY TRADE.

According to the Berlin journal *Export*, the following statistics represent the movement of the trade in the years 1880 and 1881 :—

	Exports.		Imports.	
	1880.	1881.	1880.	1881.
	cwts.	cwts.	cwts.	cwts.
Green and dried chicory...	242,978	206,154	99,390	182,988
Burnt and ground chicory	178,382	164,154	13,938	15,536

It is stated that out of the 182,988 cwts. of fresh and dried chicory imported in 1881, no less than 163,648 cwts. came from Belgium, and a considerable part of the remainder from Holland. The movements of imports and exports represent, it is said, a total value of about £275,000 per annum. The principal centre of the growth and manufacture of chicory in Germany is the district of Magdeburg. The use of chicory as an admixture with coffee is said to be more general in France, Belgium, and Austria than in Germany. Its use in the last-named country is stated to be mainly confined to the lower classes, but the wants of home consumption are of sufficient importance to require annually about 1,000,000 cwts. of unmanufactured chicory.

Considerable interest has been taken, it would seem, in a new application of chicory, which has been discovered by the researches of Herr Bartels. On account of the similarity of its composition to barley, and on account of the amount of bitter principle it contains, it is said to be applicable to the manufacture of a description of beer. Should the technical researches in progress confirm this supposition, it is remarked that the growth of chicory would acquire considerably augmented importance as a branch of German agricultural industry.

Correspondence.

RAILWAYS IN INDIA.

On the paper on "Land Assessment in India," read by Mr. Pedder, published in your *Journal* of 13th April, the chairman, Sir James Caird, remarked that for the prevention of famines in India, railways should be increased.

For the prevention of famines, not extension of railways, but irrigation works are required, which will go to the root of the evil, which will increase the produce double at least, and, according to Blue-books,

pay better financially than railways; again, in several parts, the irrigation canal will serve to carry the produce at a cheaper rate than railways. Irrigation works will help far more to prevent famines, and famine loans, and famine taxation, than extension of railways.

Government cannot derive land-tax unless there is agricultural produce. On best irrigated lands, Mr. Pedder stated, land-tax is Rs. 15, and even higher. But this is an extreme case. Put the land-tax Rs. 4, or 2 on irrigated lands against Rs. 1 for unirrigated lands, and the gain to the Government revenue is seen at a glance.

If, in London, companies can be formed to construct more railways in India, by all means let them do so. Let Government give them land free, as it is hardly of any value, but to give any guarantee or subsidy is a great mistake.

In a word, for the prevention of famines in India, what is required is that the extreme poverty in India should be removed by increasing agricultural produce, promoting manufactures, as done in the English Colonies, developing her coal and iron mines. To construct more railways in a poor country is like giving a stone to a hungry man, is the conviction of one who has studied the subject from all points for more than ten years. P. R. Cola.

Manchester, 24th April, 1883.

Obituary.

General Scott.—Major-General Henry Y. D. Scott, C.B., F.R.S., late Royal Engineers, died at his house, Silverdale, Sydenham, on Monday, April 16th, aged 61. He had been actively employed up to a short time before his death, and had just finished superintending the construction of the great International Fisheries Exhibition. General Scott acted formerly as Instructor in Surveying and Practical Astronomy at Chatham, and also as Examiner of Military Topography for the Military Education Department at the War Office. When he retired from the Army in 1871, he became Director of Buildings at South Kensington, acting as architect to the Royal Albert Hall and Science Schools. He was also Secretary to the Royal Commissioners of the 1851 Exhibition. He devoted much attention to the utilisation of sewage, and took out a great number of patents in connection with this subject. Perhaps the most important of the processes he invented was one for the manufacture of cement from the sludge obtained by precipitating sewage. This process was for some time carried on at Burnley and elsewhere. General Scott was elected a member of the Society of Arts in 1865, and was a member of the Council from 1865 to 1876. On May 17, 1872, he read a paper on "A New Mode of Dealing with Sewage Precipitate" (*Journal*, vol. xx., p. 547), and on November 26, 1876, he read another paper entitled "Suggestions for Dealing with the Sewage of London" (*Journal*, vol. xxviii., p. 19); for this latter paper he was awarded a silver medal by the Council. General Scott also contributed papers to the Society's Sanitary Conferences.

General Notes.

Royal Institution.—Professor Tyndall will commence on Thursday next (May 3) a course of three lectures on "Count Rumford, Originator of the Royal Institution."

St. Petersburgh Horticultural Exhibition.—The proposed International Horticultural Exhibition and Botanical Congress, which was announced to be held this year at St. Petersburgh, has been postponed until 5th May, 1884, in consequence of the Czar's coronation.

Denver Mining Exhibition.—A National Mining and Industrial Exhibition, at Denver, Colorado, U.S.A., will be opened on 17th July next, and will close on 30th September. An Act has has been passed by the Senate and House of Representatives of the United States, admitting free of duty articles intended for the Exhibition.

Vienna Electrical Exhibition.—Information has been received through the Foreign-office that the Austro-Hungarian Railway authorities propose to grant reductions on the carriage of goods intended for the forthcoming International Electrical Exhibition at Vienna. Insurance on objects sent to the Exhibition is granted as an exception to the usual rules. These facilities are only good during transit from Austro-Hungarian stations to Vienna, and *vice versa*. The goods must go by goods train; if sent by passenger train (as express goods) the full rates will be charged.

Zapallo Fruit.—The fruit of the zapallo, a cucurbitaceous plant of Uruguay, appears to afford a most wholesome food. It is cut up with the saw, because the rind is too hard for a knife to penetrate. It is firm, of a yellow colour, a sweet amylaceous flavour, and slight smell resembling that of the carrot. The most esteemed quality, called rubango, has a ligneous rind of a dark green colour, with orange pulp, and white oily seeds. The relative proportions are:—Seeds 4, pulp 59, and rind 57. According to M. Sace, the chemical composition is as follows:—Gum, 0·44; sugar, 2·52; starch, 13·73; fibrine, 0·47; lignose, 0·22; ash, 0·81; water, 81·81 total, 100·0.

INDIAN SECTION.

At a meeting, held on Friday, April 20th, Mr. A. CASSELS in the chair, a paper was read by Surgeon-General FRANCIS DAY, on "The Fisheries of India."

The report of the meeting will be printed in next week's *Journal*.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

MAY 2.—"Electricity as a Motive Power." By Prof. GEORGE FORBES. W. H. PREECE, F.R.S., will preside.

MAY 9.—"English and Foreign Silver Work; with Some Remarks on Hall-markings." By WILFRED CRIPPS, F.S.A. Sir PHILIP CUNLIFFE-OWEN, K.C.M.G., C.B., C.I.E., will preside.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings at Eight o'clock:—

MAY 24.—"The Development of Electric Lighting." By J. E. H. GORDON, B.A.

INDIAN SECTION.

Friday evenings at Eight o'clock:—

MAY 25.—"Some Notes on the Domestic Architecture of India." By C. PURDON CLARKE.

CANTOR LECTURES.

Monday evenings at Eight o'clock:—

Fourth Course, on "The Transmission of Energy." By OSBORNE REYNOLDS, M.A., F.R.S., Professor of Engineering at Owens College, Manchester.

LECTURE II.—APRIL 30.

The storage of, and conveyance of stored energy in forms available for power; the limited capacity of all reservoirs of energy; the limits to the possible distance through which power may be transmitted by mechanical means.

LECTURE III.—MAY 7.

The transmission of energy through pipes and conductors; summary of economic considerations relating to the transmission of energy.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Osborne Reynolds, "The Transmission of Energy." (Lecture II.)

Royal Institution, Albemarle-street, W., 3 p.m. Professor McKendrick, "Physiological Discovery." (Lecture V.)

Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr. G. King, "The Method Used by Milne in the Constructton of the Carlisle Table of Mortality."

Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Miss E. A. Ormerod, "Insect Injuries to Farm Crops and their Prevention."

Medical, 11, Chandos-street, W., 8½ p.m.

Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. The Secretary, "The Origin, Arrangement, and Results of the System of Professional Examinations."

Zoological, 11, Hanover-square, W., 1 p.m. Annual Meeting.

TUESDAY, MAY 1...Royal Institution, Albemarle-street, W., 2 p.m. Annual Meeting.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on "Resistance on Railway Curves."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m. 1. Observations by Professor F. Delitzed, on "Babylonian Chronology." 2. Paper by Rev. A. Löwy. 3. M. Alex. Enman, "Notes on the Origin of the Cypriote Syllabary." 4. Dr. Birch, "Notes on Hieratic Ostraka, at Queen's College, Oxford." Mr. Ll. B. Atkinson, "Modern Electric Generator."

Science Society, King's College, Strand, W.C., 8 p.m.

WEDNESDAY, MAY 2...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Professor George Forbes, "Electricity as a Motive Power."

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 4½ p.m.

Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

THURSDAY, MAY 3...Linnean, Burlington-house, W., 8 p.m. 1. Mr. J. G. Howard, "*Cinchona Ledgeriana*." 2. Mr. W. Percy Sladen, "Asteroidea of the *Challenger* Expedition." (II.) 3. Professor W. T. Thiselton Dyer, "New Species of Cycas from Southern India." 4. Mr. G. Brook, "Revisiou of the Genus *Estomobrya* (Degeeria)." 5. Rev. R. Boag Watson, "Mollusca of *Challenger* Expedition."

Chemical, Burlington-house, W., 8 p.m. 1. Dr. Edward Divers and M. Thimosé, (*a*) "A New Oxide of Tellurium;" (*b*) "Tellurium Sulphoxide;" (*c*) "A New Reaction of Tellurium Compounds." 2. Mr. Watson Smith, "A Simple Modification of the Ordinary Method for Effecting the Combustion of Volatile Liquids, by Glaser's method, with Open Tubes." 3. Prof. W. R. Hodgkinson, "Acenaphthene."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Special Meeting.) Sir William Thomson, "Electrical Units of Measurement."

South London Photographic (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. 1. Mr. F. A. Bridge, "Lenses, Cameras, and Stands for Small Work." 2. Mr. W. Cobb, "Photography from a Balloon." 3. Discussion: "When large Pictures are required, is it better to take them direct, or to take small negatives, and then enlarge them?"

Royal Institution, Albemarle-street, W., 3 p.m. Professor Tyndall, "Count Rumford."

Archæological Institution, 16, New Burlington-street, W., 4½ p.m.

FRIDAY, MAY 4...Royal United Service Institute, Whitehall-yard, 3 p.m. Colonel C. B. Brackenbury, "The Latest Development of the Tactics of the Three Arms."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. R. H. Scott, "Weather Knowledge in 1883."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m.

SATURDAY, MAY 5...Royal Institution, Albemarle-street, W., 8 p.m. Professor Geikie, "Geographical Evolution." (Lecture V.)

Journal of the Society of Arts.

No. 1,589. Vol. XXXII.

FRIDAY, MAY 4, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Prof. Osborne Reynolds, F.R.S., delivered the second of his course of Cantor Lectures on "The Transmission of Energy," on Monday evening, April 30th. He dealt in this lecture with the storage of energy, and the conveyance of stored energy in forms available for power. He then drew attention to the limited capacity of all reservoirs of energy, and the limits to the possible distance through which power may be transmitted by mechanical means.

The lectures will be printed during the autumn recess.

PREMIUMS FOR THE 129th SESSION.

The following Prizes are offered by the Council for the year 1883:—

John Stock Prize.—A Society's Gold Medal, or £20, for the best design from a poem, or from history, or from the Scriptures, prepared with a view to Mural Decoration.

Benjamin Shaw Prize.—1. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the operations of coal-mining." 2. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the manufacture, storage, and transport of explosives."

The Council leave it to the competitors to bring the plans under their notice in any way they may think proper, whether by model, written description, or otherwise.

Howard Prize.—A prize of £100 for the best Essay on the Utilisation of Electricity for Motive Power. Preference will be given to that Essay which, besides setting forth the theory of the subject, contains records with detailed results of actual working or experiment. The Society reserves the right of publishing the Prize Essay.

Fothergill Prize.—A Society's Gold Medal, or £20, is now offered for the best Invention having for its object the Prevention or Extinction of Fires in Theatres, or other places of public amusement.

Mulready Prize.—A Society's Gold Medal, "To that student in a School of Art in the United Kingdom who exhibits the best Drawing from the nude figure, executed in black and red chalk, in the manner so successfully practised by Mulready."

Designs, plans, models, essays, descriptions, inventions, &c., intended to compete for any of the above Prizes, must be sent in on or before the 31st October, 1883, to the Secretary of the Society of Arts, John-street, Adelphi, London.

Further particulars relating to the Prizes may be obtained on application to the Secretary.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, April 26; Sir H. Hussey Vivian, Bart., M.P., in the chair. The paper read was "A New Process for the Separation and Recovery of the Volatile Constituents of Coal," by T. B. Lightfoot, M.Inst.C.E.

The report will be printed in next week's *Journal*.

Proceedings of the Society.

INDIAN SECTION.

Friday evening, April 20th, 1883; Andrew Cassels, Member of Council, in the chair.

The paper read was—

THE FISHERIES OF INDIA.

By Francis Day, F.L.S., F.Z.S.,
Deputy Surgeon-General (retired), formerly Inspector-General of Fisheries in India.

The subject which I shall have the honour to bring before you this evening is that of the Fish and Fisheries of India and its depen-

dencies. Possibly there are other questions pertaining to the East which would prove more attractive and likely to engage attention than fish; but I think there is not one which could be selected more directly interesting to the teeming millions of our Indian Empire, and which requires so much investigation from our legislators, philanthropists, and scientific inquirers.

Doubtless one, perhaps the greatest, reason many persons take an interest in this class of the vertebrate animals consists in the food they afford, and the occupation they give to man. But when we consider the subject more closely, we find that in our everyday life we are profiting extensively from the lessons our ancestors have received from the finny tribes. Man, in his savage condition, has the very natural instinct of desiring food when hungry. Whether he can or cannot subsist solely upon vegetables is immaterial; his canine teeth demonstrate his carnivorous propensities, and nauseated with a vegetarian diet, he would naturally seek change by the addition of animal substances. If living near water, more especially on the sea coast, the hungry savage would first resort to such molluscs, crustacea, and fish as he could capture in the shallows, or were left there by a receding tide; but as his wants increased, and the source of supply began to diminish, he would have to adopt other devices. He would wade after his prey, pursue them with spears, shoot them with bows and arrows, as the Andamanese do to this day, obtain them by setting up dams and weirs, or intoxicate them with poisons.

But again (unless consequent upon some peculiar circumstances), the time would inevitably arrive when augmented captures would be desired; man would then have to venture further out, to dive after his prey, employ nets, to float upon a log, or fasten pieces of wood together as a raft, and in due succession would come the construction of a boat, and finally that of a ship—this last being necessary for the purpose of extending his range to better fishing grounds, or exporting his spoils to distant markets. Consequently, the basis for navigation and commerce may reasonably be supposed to have been laid by man pursuing the finny tribes for the purposes of obtaining them as food, or conveying them dried or cured as an article of merchandise to transmarine countries. The very history of sea fisheries, which have been free to all, seems to point out that, as man increases in numbers, inshore captures of fish become insufficient for his requirements; or else that continuous fishing may diminish the supply, rendering it equally necessary that the fisherman's occupation should be extended to more distant localities.

Fresh-water fisheries differ in many respects from marine ones; and we are all aware that, wherever any quantity of fresh water exists in the East, there we are almost certain to find fish; and this from a sea level to nearly the summit of the highest mountains. As a natural result, fishing is had recourse to, in various ways, in rivers, irrigation canals, lakes, tanks, ditches, inundated fields, and swamps. The importance of such fisheries is not solely in a ratio as regards their productiveness, but also in accordance with the character of the adjacent people as to whether they are or not fish consumers; while the sparsity or the reverse of the population has also to be taken into account.

Where no regulations are in force for the protection of inland fisheries, and should other circumstances be equal, that country or district which is most densely populated by man will be least so by fish. Individuals would rather live by fishing than by agriculture, because the trouble of capturing the finny tribes is less than that of tilling the soil. It becomes simply catching food without a thought respecting future supply. Fish have been endowed with certain means of increase and protection—the number of their eggs may be enormous, while some forms keep guard over their eggs and likewise over their fry, in order to afford them protection from their enemies.

As, however, man increases, watery wastes (wherein the fish had been protected by grass, reeds, bushes, and the roots of trees) become drained and cultivated; predaceous man increases his means of destruction; an augmented population, possibly assisted by the unscrupulous manufacturer or miner, pollute the previously wholesome water, and a diminution of the finny tribe becomes apparent to the investigator.

With an increasing fish-eating population, an increased supply of fish thus becomes a self-evident necessity, and this must be provided for by augmented captures or dearer prices, the latter acting as a check on the poor, by more or less placing it out of their reach. This latter result may, consequently, eventuate in gradually diminishing the physical strength of the people. For a greater supply must be met from one or two sources, either from fisheries which previously have been in-

sufficiently worked, or by overworking such as exist, by means of capturing, for present use, those which ought to be left for a future season. Even if the extent of the water is so great, and the inhabitants so few, that this result need not be anticipated for several generations, still, populations under good systems of government have a natural tendency to increase. Means of carriage generally improve with time, and should neither regulation nor care of the fisheries be attempted, disastrous results must eventually be arrived at. Fish appear to have but few friends but many enemies, and investigations as to their condition generally ends in giving increased license to their captors, for it is so easy to be liberal at other people's expense. We see interested parties and philanthropists (so-called) exclaiming against the hardship to the poor in not allowing every available fish to be secured. The majority of our law-makers are content to allow the fish to shift for themselves, and to leave the fishermen to be controlled simply by their own consciences. To-day's market it is hoped will be supplied, sufficient for this season it is expected may be obtained, so let to-morrow's wants be met as they can!

The fishermen of the fresh waters of India and Burma are divisible into two main classes —first, such as follow this calling as their sole means of livelihood; and, secondly, such as engage in it only occasonally, and as a subsidiary occupation. Who, then, are these Indian fishermen? Here, even within the limits of a single or at least of a few generations, great innovations have crept in, for in the time of native rule, fishing was in the hands of distinct castes, but now it is only here and there that one comes across some remnants of these people, living in small communities, and frequently in the greatest poverty. At Combaconum, in Madras, there is a tradition that the fishing castes resident there were originally brought from Conjaveram as palanqueen-bearers; while, at Broach, in Bombay, two sub-divisions of these people are named in accordance with the villages from which they originally migrated.

In native States, fish have obtained great consideration. Thus in Mysore, in the time of Hyder Ali, very stringent fishery laws existed; whereas, at the present day, about two-thirds of the population of some divisions of the country occasionally add fishing to their other occupations, nearly every villager possessing a fish-net or trap, to be employed as occasion or opportunity arises. Now fisheries are open to all; a fisherman's calling is no longer a profitable one, mainly due to the fisheries being depopulated. When whole districts were let to contractors, they were not so short-sighted as to permit an indiscriminate destruction; but now everybody does as he likes, when he likes, where he likes, and how he likes. Thus it has come to pass that among the animal productions of India, fresh-water fish meet with the least sympathy, and the greatest persecution, many forms having to struggle for bare existence in rivers which periodically diminish to small streams, or even become a mere succession of pools, or in tanks from which the water totally disappears. They have their enemies in the egg stage, in their youth, and during their maturity; but among these man is their greatest foe, as anyone who desires a fish diet captures these creatures whenever and wherever he gets the chance, irrespective of season, age, and size. In certain districts they simply appear to exist solely because man and vermin have been unable to destroy them.

Fisheries may be let to a contractor, and if their extent is large he takes partners or sublets portions; sometimes he employs servants, who are paid partly in money, or food, clothing, and lodging, and partly in a share of the captures. In some districts the fisheries, or a portion of them, are declared free, but a license fee is charged to the fishermen. Or the general public is free to take fish for home consumption, but not for sale. Lastly, no regulations at all may exist, due to the general poverty of the fisheries, peculiar difficulties in their capture, or the general impecuniosity of the inhabitants.

When the public have, more or less, depleted fisheries, the fishermen become poorer and poorer, unless they turn to other sources of obtaining money; at first, no doubt pleased at the remission of rents, and the removal of all restrictions upon fishing, they employ redoubled energy, and thus augment their immediate profits. But soon the general public find that nothing precludes their fishing in any way they please; the markets become glutted, and the price may fall from the want of purchasers. But after two or three years fish become scarcer; fishing is no longer remunerative; removing the rents from fisheries and throwing them open to the public will not decrease the price of fish. The rates ruling in India are comparative to what obtains for meat and other articles of animal food.

Fishermen, living on free fisheries, do not dispose of their captures below market rate any more than farmers, who possess rent-free farms, and sell the produce at less than their neighbours. If the fisherman benefits, the purchaser does not, and their mis-applied energy eventuates in nothing but small fish remaining. The young have to be raised from ova of such as are merely one or two seasons old, while the younger the parent the smaller the eggs, and this, I believe, is one mode in which races of fish may deteriorate.

The rivers which have Alpine sources, as such as descend from the Himalayas, have, exclusive of springs, two most abundant sources of replenishment. During the hot months this is derived from melted ice and snow, while during the monsoons the rains assist; we may then have the hill rivers forming torrents, rising rapidly, and as rapidly subsiding, and possessing no contiguous tanks into which the fish could retire. These animals are peculiar, or endowed with means of existence differing from such as live wholly or mostly in the waters of the plains. Many of the fish are provided with adhesive suckers, situated behind the lower jaw, or placed on the chest, which enables them to fix themselves against rocks, and so prevent their being washed away by the stream.

Through the cold months, and generally until the setting-in of the south-west monsoon in June, rivers are at their lowest, some at this period (especially in hilly regions) being merely a succession of pools, united by a more or less insignificant stream, in which limited localities the fish take refuge, and may be easily secured by fishermen.

Among the artificial causes affecting fisheries in many districts are the irrigation works, which are formed by throwing a weir or bund across a river, and diverting a large amount of its water down a main irrigation canal. These weirs are usually built as stone walls across the entire breadth of rivers, and consequently impede both the upward and downward passage of fish that are endeavouring to migrate while should they be sufficiently high, they entirely stop them. Where large under-sluices are present, fish can pass up such when open; but up the long narrow ones, as constructed in Madras, the strength of the current renders this impossible. The under-sluices are here closed, except where there is an excess of water, as during the monsoon months; and as the weirs have no fish-passes, not only is ascent towards the breeding-grounds intercepted, but fishermen are permitted to capture the fishes which are detained here. Standing on those weirs, one can see the fish jumping against the obstruction, which they vainly hope to surmount; some strike against the piers of the bridge, others fall into the cascade, descending over its summit; but to them the wall is an impassable obstacle.

The irrigation canals may be said to be streams obtained by diverting a large amount of water from a river into a new channel, and this, of course, would be taken from above the weir; consequently, all fish descending the river would be diverted into the irrigation canal. If these canals are constructed for navigation as well as for irrigation, the fish can pass along them; but if due to falls, they are unsuited to navigation, then the fish can descend them, but are unable to re-ascend. They then become vast fish traps, wherein all the finny inhabitants are destroyed whenever the canals are run dry in order to examine their condition and see what annual repairs are necessary. Passing off on either side of these canals are lateral irrigation channels, which are employed to directly water the crops, and at each successive replenishment of these, another shoal of fish passes to inevitable destruction. Unprovided with gratings at their entrance, and only kept filled on alternate weeks, all the fish which enter invariably perish. The same destructive process exists throughout India wherever irrigation is carried on.

As the yearly rains cause inundations of the country by the overflowing of the rivers and tanks, fish move about in order to find suitable localities for breeding in, and the small streams and their outlets resemble the network of irrigation channels. Many species ascend them to spawn, but find, at every turn, appliances invented by man ready for their destruction. Persons may be watching to intercept them, engines or traps may be fixed in their course; or, should any breeding fish succeed in effecting their ascent, means are taken to ensnare them on their return, whilst the fry are destroyed in enormous quantities—a proceeding which has been declared not to be waste because they are eaten.

Then there are tanks, some of which are, others are not, in connection with running water. Should they entirely dry up during the hot months, only such fish as bury themselves in the mud will survive to the next rainy season. As a rule, the owner of a tank, if

it is employed also for fish-culture, leaves one portion (the deepest) in order to retain sufficient water to keep the finny residents alive, while, if very hot, boughs of trees or tatties are placed over this locality to mitigate the heat.

I shall now pass on to consider the fishes inhabiting the fresh waters of India, Burma, and Ceylon. They may be divided into (1) those which enter from the sea for breeding or predaceous purposes; and (2) such as, more or less, pass their lives without descending to the salt water. The first class I do not propose giving any detailed description of, unless casually remarking upon such when the breeding of fish or the fisheries come under review.

An exhaustive account of all the strictly fresh-water forms would doubtless be interesting scientifically, but hardly so to the fisherman or general reader; consequently I shall restrict myself to observing that the fisheries alluded to contain about 369 species, appertaining to eighty-seven genera. Of the spiny-rayed, or *Acanthopterygian* order, we have nineteen genera, the members of which are most numerous in the maritime districts and deltas of large rivers, while their numbers decrease as we proceed further inland. Few are of much economic importance, if we except the common goby, spined-eels (*Mastacembelidæ*) the snake-headed walking fishes (*Ophiocephalidæ*), and the labyrinthiciform climbing-perch and its allies.* Of the sheat-fish, or scaleless siluroids, we have twenty-six genera; the mouths of these forms are provided with sensitive feelers, which, serving as organs of touch, assist them while seeking their prey in turbid waters. All that are of sufficient size are esteemed as food, although, owing to their propensity for consuming unsavoury substances, their wholesomeness appears, at times, to be questionable. The next three genera, gar-pike (*Belone*), Cyprinodon, and Haplochilus, are of but little value, but the thirty-five genera of carps and loaches are of the greatest possible consequence, affording a large amount of food to the population of the country. The remaining four genera, consisting of the curiously flattened *Notopterus*, and three forms of eels, are of but little mercantile importance.

* These air-breathing fishes are of great economic importance; thus, when poisonous ingredients are washed into rivers, on the first burst of the monsoon, the fishes die, unless they are direct air-breathers, taking in atmospheric air direct, when they are often able to exist until the poison has passed down stream.

How the reproduction of these fishes is carried on becomes a most necessary investigation, and in briefly considering such, we might inquire into what migrations they undertake for this purpose? Whether the parents are monogamous, polygamous, or are annuals, dying after the reproductive process has been accomplished? The time of year when spawning occurs? Whether such is or is not deleterious to the parent? The size of the eggs, their colour; whether they float or sink; are deposited in running or stagnant waters? If they are covered or left uncovered in their nests? If the male carries them about or protects them? Can their germination be retarded by artificial means or natural causes, as by the action of cold or their immersion in mud?

That anadromous forms, as the salmon or shad of Europe, or the shad *(Clupea palasah)* of India, migrate from the sea to the fresh waters to deposit their eggs in localities most suitable for their reception, is well known. If we examine into the migration of Indian fishes for breeding purposes in fresh waters, we find such takes place under three conditions, viz.:—(1) anadromous forms from the sea to the fresh waters, as already adverted to; (2) such species as may be considered pertaining to the mountains, or else deposit their ova in the rivers of the hills; (3) such as are restricted to the plains, but which likewise undertake certain changes of locality at these periods. Of the migratory hill fishes, the various forms of large barbels, *Barbus*, termed *Mahaseers*, furnish good examples. In the Himalayas they ascend the main rivers, but turn into the side streams to breed; while on the less elevated Neilgherry mountains, in the Madras Presidency, the same phenomenon occurs, but with this difference, that they deposit their ova in the main streams because such are small, and perhaps due to their never being replenished with snow-water. Occasionally the fish are too large to ascend these mountain rivers, when they would appear to breed at the bases of the hills; whether it is from the offspring of such that this genus has extended through the plains it is not my purpose to inquire in this place. When the rivers commence being in flood, adults are able to ascend to feeding grounds which were previously inaccessible to them. Having spawned, they keep dropping gently down stream, during which time the amount of water is diminishing; thus the ova, when hatched, are completely cut off from the

locality where their parents reside, precluding their making a meal of them. The fry, therefore, have the heads of the rivers to themselves in perfect security, and each torrent becomes transformed into a small stream intersected by pools, where they can remain until the next rain enables them to descend to the larger rivers. Of the migratory fishes of the plains, we may observe many forms of carp, and this is more particularly observable where impassable weirs exist in Indian rivers; here they may be perceived in attempting to jump over the obstruction, and so common is this phenomenon that the natives of India hang baskets, cloths, even native cots turned upside down, or anything equally suitable, over the sides of the piers, and into this the fish fall.

In Asiatic waters we have monogamous and polygamous forms and other phenomena as to breeding, which deserve attention. The walking, or snake-headed fishes, *Ophiocephalidæ*, of India, and other amphibious genera, are perhaps the best known of monogamous fishes; some of them reside in ponds, others prefer rivers, where they take up their residence in deserted holes, which they find in the banks. The pond species delight in lying at the grassy margins, where the water is not deep enough to cover them; and here they are able to respire atmospheric air direct. The striped walking-fish constructs a nest with its tail among the vegetation, and bites off the ends of the water weeds; here the ova are deposited, the male keeping guard; but should he be killed or captured, the vacant post is filled by his partner. The hissar, *Callichthys*, of South America, is likewise monogamous, constructing nests, which it also defends. The majority of fishes unquestionably are polygamous, as has been repeatedly observed, and perhaps as distinctly among the salmon as any other form in a wild state, and likewise in sticklebacks resident in aquaria; while, doubtless, fishes which migrate in shoals for breeding purposes, as the mackerel, herrings, or some forms of carp, are all polygamous.

The time of year at which spawning is effected varies in accordance with the locality and the family of fish. This again appears to be further susceptible of modifications in accordance with the temperature of the water, and many other local causes, while there are some fishes which only breed once a year, others more frequently. I must here premise that some fishes do not appear to feed during the season of depositing their spawn, as the salmon, the shad, and the siluroid *Ariinæ*. In India an anadromous shad, termed "Pulla" in the Indus, "Ulum" by the Tamils, "Sable-fish" by the Madrassees, "Palasah" by the Telingis, "Hilsa" or "ilisha" in Bengal, "Nga-tha-louk" by the Burmese, breeds in rivers as already described. In Sind they ascend the Indus in February to spawn, descending in September. In the Cauvery, in Madras, they pass up when the first burst of the June monsoon fills the river, and they continue doing so for the succeeding four months. In the Kistna, which has a far greater velocity, but, similarly to the Cauvery, is filled in June, they defer their ascent until September, but it is not until the end of the month, or commencement of October, when the river is subsiding, and its velocity decreasing, that the majority arrive; whereas in the neighbouring river, the Godavery, in which the current is less rapid, these fishes ascend earlier to spawn, being most numerous from July to September. In the Hooghly they continue ascending throughout the June monsoon, and many are found still in roe in September. The main bodies of these fish ascend the large rivers of India and Burma generally when the June monsoon commences, but not always at the same period, such apparently at times being dependent upon the rapidity of the current and other causes. That it is not solely due to the presence of rain-water flooding the rivers is evident, because those of the Indus and Irrawaddi are mainly caused by melting snows at this period, and likewise in the latter river these fishes push on to Upper Burma, to which country the monsoon scarcely extends, but where the inundations are due to snow floods. Probably the cause of the majority of fishes at these various periods ascending the different rivers to spawn may be due to their having been bred there, while inherited instinct causes them to select the most suitable times, when the shallows are covered with water, and ascent is rendered practicable.

It is evident that members of the same family, genus, or even species, may spawn at very different periods, due to local or climatic causes. There are also fishes which deposit their ova twice yearly, if not more frequently; these are generally freshwater forms, and not rare, especially in tropical countries; as an example, we have the walking fishes.

Has the effect of spawning any deleterious effect upon the parent fishes? To this two replies may be given, as in some cases it renders their flesh unwholesome, while in others

it does not cause their character as to food to be altered. The shad in the East are excellent eating up to the period when they have deposited their eggs, subsequent to which they become thin, flabby, and positively unwholesome; the salmon have similarly an unhealthy lean and lank condition, rendering them unsuitable for the table. Freshwater fishes that deposit a smaller number of eggs, or perhaps do so more gradually, or twice at least during the year, do not invariably appear to be so deleteriously affected by breeding, this condition being more restricted to the anadromous forms.

The size of the eggs, their colour, and whether deposited in ponds or in the sea, are likewise questions affecting the breeding of fish. The forms which produce the greatest number of eggs are often those which live in large communities and spawn once a year. In an Indian shad I found 1,023,645 eggs. But other forms have likewise numerous eggs. I observed 410,500 in a barbel (*Barbus sarana*); on the other hand, some fishes have large eggs, as a few of the sheat fishes, and a genus of carps (*Barilius*). In such as spawn at least twice a year, and likewise protect their young, the number of eggs is less than what generally obtains in other genera; thus in a walking-fish (*Ophiocephalus*), I found 4,700.

As to the colour of fish eggs, they are very diversified; in some fresh-water siluroids they are of a light pea-green, as I have observed in the scorpion fish, *Saccobranchus fossilis*. Respecting the localities where fish deposit their eggs, these are exceedingly various, as might be anticipated, owing to some sinking in the water, while others float. The gar-fish (*Belone*), and the flying-fish (*Exocœtus*), have filaments springing from their eggs for the purpose of attaching themselves to contiguous objects; others are covered with a glutinous secretion. In fresh waters eggs may remain at the bottom, either covered or uncovered.

Among the marine siluroids (*Ariinœ*), the male carries about the large eggs in his mouth until hatched; or it may be that he only removes them from one spot to another to avoid some impending danger. However this may be, I have netted many along the sea-coast with from 10 to 20 eggs in their mouths, and in one example was a young fry just hatched. In none of these large males was there the trace of any food in their stomachs.

Bloch, at the end of the last century, made many experiments as to the feasibility of fish being artificially hatched, and also whether it were possible to convey the ova in safety for any considerable distance. He proposed placing the eggs of pond-fish in mud, similar to that existing in the locality from whence the eggs were procured, and he believed that when the mass had dried, they could be thus removed without injury from one pond to another. His proposal was based upon the theory that frequently on dried-up ponds being refilled with water, young fish appear, and which could only be due to the eggs having been present in the mud, but with their germination suspended. In India, as ponds dry up, some of the fish contained therein descend into the mud, where they æstivate until the the next year's rains set in. As these commence, and the mud liquefies, fish are perceived diverging in all directions, up every watercourse, no matter how small, or how lately it may have been dry, while in a few days fry are distributed everywhere. Where the eggs come from which have produced these fry is a very interesting subject for investigation. Have they remained inside the mother fish, and did she deposit them as soon as the rains set her free? I cannot accept this theory, because I have witnessed fish removed alive from the mud, but they had no ova; and secondly, because the fry are so soon hatched after the setting in of the rains, while some of these fish are ovi-viviparous. It seems more reasonable to suppose that the fertilised eggs are embedded in the mud, and, as soon as the rains occur, they become hatched out, and this would give us reason for attempting to ascertain whether ova of pond fishes imbedded in mud could be successfully transported long distances.

We know that germination of fish eggs can be retarded by cold. In fact, by the use of ice, those of trout and salmon have been safely conveyed to Tasmania and elsewhere.

From the information collected between 1869 and 1873, it appeared that the fisheries in olden times were royalties, mostly let out to contractors, who alone in their respective districts possessed the right to sell fish, while they, as a rule, permitted the people, on payment, to capture sufficient for their own households. It was, in fact, a license on payment, resumable at will. Remains of this custom still exist in Lahore, while the leasing of fisheries is even now in force in many portions of the Indian empire. Along the Himalayas, in the Kangra and other districts, the petty rajahs adopted a different method. To some persons they gave licenses to supply the fish markets,

of which they virtually made them monopolists, while others obtained licenses for fishing with small nets for home consumption, but not for sale. In Burma, under native rule, a similar plan was carried out. There were no free fisheries; but inhabitants had the privilege—or perhaps right—to fish for home consumption on the payment of a fixed annual sum to the contractor for the district in which they resided. It is believed, under native rule, the erection of fishing weirs was permitted in several of the streams in the Himalayas, but not to the extent that they are at the present day. In some districts landowners even now raise an income from the fisheries, claiming a third of the captures or a certain amount of money. Some of our officials consider that, as Government has permitted indiscriminate fishing, the exercise of long practice has converted such into a communal right.

As British rule has gradually superseded that of the native princes, so the modes in which fisheries were leased has become widely different, and in permanently settled estates, unless a stipulation to the contrary exists, they go with the land. In some localities it has been decided that the adjacent villagers or people possess certain communal rights with respect to them, due, it seems most probably, to a misapprehension. Although it has been proved that the landowner never received more than one-third of the produce, this does not demonstrate that the other two-thirds were public property, but that such expressed the share accruing to the fisherman in return for his labour in capturing the fish. It is the rule in India and Burma to remunerate by the proceeds — sometimes the working fisherman has to dispose of his share to the contractor or lessee at a given rate; more rarely the fish are sold, and he receives a proportion of the returns, or he may be paid in kind. In some localities the British Government has leased fisheries, or imposed a tax on the implements of fishing, or a capitation tax upon the fishermen, but without interfering with the manner in which the fisheries were conducted. By degrees the tax on fishing implements was taken off, but the fishermen still became poorer, and in 1849, at least in Madras, many leased fisheries were thrown open to the public, resulting, as they were not regulated, in unlimited license, and thus an intended boon eventuated in their depopulation. In Burma, the practice of employing fixed engines in irrigated fields and watercourses very largely increased when the native *règime* became abolished, as did also the custom of throwing weirs across creeks and minor streams.

Free fisheries have been permitted, due to several causes, such as the difficulty in making such sufficiently remunerative to bear taxation or the incidence of rent; this may be owing to the rapidity of the current, the paucity of fish, as in some hill streams and depopulated rivers, the depths of tanks, the presence of foreign substances, in them, or the poverty of the general population. How general and indiscriminate fishing ruins fisheries, without any commensurate benefit accruing to the public, I have already stated. In these deteriorated but public fisheries, as soon as the monsoon has set in, and the fry are commencing to move about, women and children are daily engaged in searching for them in every sheltered spot where they have retired for security, as, not being able to face strong currents, or live in deep waters, they naturally resort to the grassy but inundated borders of rivers and tanks. Every device that can be thought of is now called into use; nets which will not permit a mosquito to pass are employed; even the use of cloths may be frequently observed. Neither are the agricultural population idle. They construct traps of wicker-work, baskets, and nets; these traps permit nothing but water to pass, and a fish once inside is unable to return, as they resemble some of our commoner kinds of rat-traps. So soon as fish for the purpose of breeding commence passing up the small watercourses at the sides of rivers and streams, these implements of capture come into use; breeding fish are taken, and the few which surmount the obstructions find the traps reversed, so that, although they have ascended in safety, it is by no means improbable that their return to the river will yet be cut off. In Burma a large triangular-shaped basket is employed in places where trapping is difficult, and a pair of buffaloes having been harnessed to it, such is dragged through the localities inhabited by the fry. Even when there are no restrictions, fishermen often find it advantageous to ply their occupation in concert. Sometimes large bodies of villagers proceed at certain seasons of the year to rivers which can be easily bunded, having done which, they kill every fish they are able.

In investigating what is the minimum size of the meshes of the nets in general use in India and Burma (excluding Sind), where no regulations exist declaring what such should

be, I received the following replies from ninety-one native officials, who refer to inches :—

Native officials.	Size in inches between knot and knot of meshes.
5	1 inch.
5	Below 1 inch.
18	$\frac{1}{2}$ inch.
5	$\frac{1}{3}$,,
24	$\frac{1}{4}$,,
1	$\frac{1}{5}$,,
5	$\frac{1}{6}$,,
18	$\frac{1}{8}$,,
4	$\frac{1}{10}$,,
2	$\frac{1}{12}$,,
3	$\frac{1}{16}$,,
1	$\frac{1}{32}$,,

And out of seventy more returns, fifty-three officials compared the size of the mesh to a grain of wheat, mothi, mucca, gram, dholl, lamp-oil seed, barley, tamarind seed, a small pea, a peppercorn, a large needle, a bodkin, quill, coarse muslin, will ensnare a gnat, or hardly anything will pass. The remaining seventeen described the smallest size as follows :—Size of finger or thumb, five; of half ring-finger, two; as big as a broomstick, one; size of half rupee, one; of a four-anna bit, one; of a quarter of an anna, one; of a two-anna bit, five; of a pie, one.

The fixed engines employed in India and Burma are mainly divisible into two forms—(1) those manufactured of cotton, hemp, aloe fibre, coir, or some such material; and (2) others constructed of split bamboo, rattan, reed, grass, or some more or less inelastic substance. Those which are manufactured of elastic substances include all stake-nets, but when the meshes are of a fair size, they are a legitimate means, when properly employed, for the capture of fish, but are occasionally to be deprecated, especially when used solely to take such as are breeding. But in some of these implements the size of the mesh is so minute that no fish are able to pass. There it stands, immovably fixed across an entire waterway, capturing everything, the water being literally strained through it. In one instance, in the Punjab, a whole drove of mahaseer were observed to be captured by natives fixing a net across a river, and then dragging another down to it, thus occasioning wholesale destruction, and ruining the rod fishing for the succeeding season. This plan is a very common procedure throughout India, as is also constructing earthen dams across streams, leaving a channel or opening through their centre, where a purse-net is fixed, and arrests every descending fish. The largest numbers are taken towards the end of the rainy season, for as the waters fall, countless lakes and pools of all sizes are formed on the low lands in the vicinity of rivers. These, which during the floods were lateral extensions of the stream, now become lakes, having one or more narrow outlets into the river; across each opening nets are stretched, or a weir of grass constructed, and every fish which has wandered up becomes a certain prey to the fishermen.

Fixed engines constructed of non-elastic substances are still more destructive to fish than are such as are made of net, and which are more liable to be rent. Their forms are exceedingly numerous, their sizes infinite, while the interstices, between the substances of which the weirs or traps are composed, appear everywhere much the same, whether examined in the ghâts of Canara, the Yomas of Pegu, the Himalayas, or on the plains of India or Burma. Still, local influences must occasion some modifications. In hilly districts, as the monsoon floods subside, and the impetuosity of the mountain torrents has decreased, they can be erected without being liable to be washed away. Up the hill streams (as I have already observed), some of the most valuable of the carps ascend to breed, and there are now but few that are not weired, and the parent fishes have the greatest difficulty in reaching their spawning grounds. Some, however, surmount the difficulties opposing their ascent, a few deposit their spawn; this completed, the rains are now passing off, the force of the current lessening; but what now occurs to those fishes who commence descending, trying to regain their low country rivers? I omit in this place how spearing, snatching, or snagging, netting, and angling are carried on, only referring to how fixed engines are employed. Weirs are now erected every few miles, through which the waters of the hill streams are literally strained, while each is fitted with a cruive or fishing-trap. The probabilities are that the great majority of the mahaseer which reach the rivers of the plains are the last year's fry that have fortunately escaped destruction during the dry months, and with the first floods have obtained a free highway by the standing weirs being swept away. Wicker traps are likewise constructed across convenient rapids; here few fish can pass without entering, while these are examined twice daily. Or should there be no rapids, such are artificially formed by laying large stones in a V shape across a stream, while at the

apex of this is a trap. Or a mountain stream is conducted down a slope over a large concave basket, so that all descending fish are pitched into it, and speedily suffocated by the rushing water or other falling fish, which act like a succession of blows, preventing their ever rising again.

In addition to the larger weirs and traps, there are minor sorts most extensively employed, especially in the plains — some to capture breeding fish ascending up the smaller water-courses during the rain to deposit their spawn, others to arrest them and their fry attempting to descend the stream as the flood waters recede; and there is not a district, except perhaps in Sind, that this mode of capture is not carried on. And some officials now speak of the use of these contrivances as communal and prescriptive rights, and their prohibition as an interference with private property.

Moveable fishing implements are of two varieties, (1) those manufactured of cotton, hemp, aloe-fibre, coir, or of some such material, and (2) others made of split bamboo, rattan, reed, grass, or other more or less inelastic substances. Large drag-nets, having fairly-sized meshes, are used mostly during the dry months, and employed for the purpose of obtaining fish from pools in rivers into which they have retired awaiting the next year's floods. But the moveable nets which occasion the most damage are those with small meshes, and principally employed for taking the fry of the fish as they are first moving about; they may be cast-nets with fine meshes, wall nets dragged up some small watercourses, purse-nets similarly used, and even sheets may be thus employed. In some places several cast-nets are joined together, to stop up all passage of fish along a stream, while others are employed above this obstacle; or several fishermen surround a pool, each armed with a cast-net, and these they throw altogether, giving the fish but little chance of escaping. In Sind the fishermen float down the Indus, in certain suitable localities, upon a gourd or hollow earthen pot, while the net is let down beneath them; as a hilsa fish, *Clupea ilisha*, ascends up the muddy and rapid stream, it strikes against the dependent net, which is made to contract like a purse by means of a string that the fisherman holds in his hand.

Irrespective of the modes already detailed as in common use for capturing fresh-water fish in India and Burma, there are a number of what may be termed minor plans likewise in force. Sheets have already been remarked upon as employed for taking the fry which have ascended small watercourses, or are found in shallow water, while they may also be used as dip-nets, being sunk in an appropriate place, and raised by strings attached to the four corners, as soon as the little fish have been enticed above. Or on the bushes sheets may be placed; here the fry seek shelter from the rays of the sun, and the whole concern is lifted bodily up. A little grain or bread is likewise found useful as a bait. Two pieces of rattan may be employed, crossing one another in the middle, where they are tied together: the ends are then bent downwards in the form of two arches. Here a net is attached, and this the fisherman presses down upon the fish, which are then removed by the hand. In some places they may absolutely be so frightened as to permit themselves being readily taken; thus ropes to which at intervals are attached bones, leaves, stalks of kurbi or jowaree, or pieces of solar (pith) or small bundles of grass, are stretched across a stream; two persons, one at either end, constantly jerk this rope, causing the fish to dart away towards nets that are fixed to entrap them. Snares of the most varied descriptions are almost universally employed; but in some localities angling may be said to be almost unknown, especially in Orissa, or districts where wholesale poaching is preferred as easier and more successful. One method of using hooks is perhaps as cruel as could well be devised. A number are securely fixed, at regular intervals of about three inches, to a line for employment in a narrow pass in a hill stream. When used, the rope is sunk from eighteen inches to two feet below the surface, and held by a man on either bank; others drive the fish towards this armed cord, and as they pass over it, the line is jerked for the purpose of hooking the game. In some places dexterity has been arrived at by constant practice, and many fish are thus captured. The desire is to hook the game by its under surface; but, as might be supposed, although in some cases the hooks penetrate sufficiently deep to obtain a secure hold, such is by no means invariably the case. The struggles of the wounded creature frequently are sufficient to allow it to break away, often with a portion of its intestines trailing behind it. If its gill-covers have been injured, respiration may be wholly or partially impeded; crippled, it wanders away to sicken and die in an emaciated state; while, should it be captured

before death has stopped its sufferings, it is useless as food, unless to the lower animals. Baited hooks are in some places fastened to lines, which are tied to bamboos fixed in the beds of rivers, or to bushes or posts at their edges, and so managed that when a fish is hooked the line runs out. Or a somewhat similar plan is to have a cord stretched across a river, floated by gourds; to this the short lines which have the baited hooks are attached, but so that they are not long enough to reach the bottom; these are visited every few hours. In some districts night-lines are baited with frogs. Spearing fish by torchlight is extensively practised in the Punjab and in the Presidency of Bombay; or they may be speared during the daytime in the cold months of the year, when they are not very active. Two persons usually engage in this occupation; the one punts the boat along as noiselessly as possible, while the fisherman stands at the prow, silently pointing to the direction to be adopted, and uses his spear when he gets a chance. Shooting fish with guns is carried on in Oude, and occasionally elsewhere. This is more especially employed for the snake-headed walking fishes (*Ophiocephalidæ*), which are frequently seen floating on the surface of the water, as if asleep. They may be approached very closely, but the game usually sinks when killed, and has to be dived for, or otherwise obtained. Crossbows are also employed for a similar purpose in Malabar. In Mysore—observed the native officials of the Nagar division—fish are taken by nets, traps, hooks, cloths, by the hand, by baskets of different shapes, by damming and draining off the water, by shooting, by striking them with clubs, with swords, or with choppers, by weirs, and by various descriptions of fixed engines; in short, by poaching practices of every kind, as well as by fishing with rods and lines, and poisoning pools of water. Even fishes' eggs do not escape the general hunt to which the persecuted finny tribes are subjected in these days, the ova being collected and made into cakes, which are considered a delicacy.

There are certain vermin in the East which are destructive to fish, some when in the immature, others when in their matured state. Commencing with the crocodiles, two distinct genera have representatives in the waters of India. The true fish-eating crocodile, *Gavialis gangeticus*, with its long and slender snout, attains upwards of twenty feet in length, and is a resident throughout the main courses and affluents of the Indus, Ganges, Brahmapootra, and Mahanuddi rivers, but absent from Burma, and most of those in Bombay and Madras. This species is usually timid of man, excepting when he invades the locality where it has deposited its eggs. Their diet appears to mainly consist of fish, turtles, and tortoises. In 1868, I found it was one of the sights of Cuttack to watch these enormous reptiles feeding in the river below the irrigation weir which impedes the upward ascent of breeding fish. The long brown snout of the crocodile would be seen rising to the surface of the water, holding a fish crosswise between its jaws; next, the finny prey was flung upwards, when, descending head foremost, it fell conveniently into the captor's comparatively small mouth.

Crocodiles, similarly to predaceous fishes, swallow the finny tribes head first, because, if they are of the spiny-rayed forms, their spines are thus pushed backwards, lie flat, and do not injure the creature which is swallowing them. Were they taken in tail first, this would erect the spines, and wound every animal which should endeavour to swallow them. Doubtless some forms, while in transit, wriggle themselves round, and get fixed in the gullet of their captors, as the father-lasher of our coasts.

To show their prolific powers, I may observe that the overseer in charge of the Narrage weir in Orissa came across a brood, and within three hours shot sixty-nine. When at this place I obtained a young one that had become entangled by its teeth in a fishing net, and asked the fishermen if they ever destroyed them. Astonishment was depicted on their faces, and they protested against the supposition that they had ever been guilty of such a mean action. Their argument was that both classes belonged to the fish-destroying races, therefore on the principle that hawks do not pick out hawks' eyes, they consider it would be wrong to cause their deaths. As to the destruction they occasioned, they admitted it, but also observed that they would do as much if they were able. It must not therefore be hoped that fishermen will assist in clearing rivers of these monsters; neither will the native sportsman throw away a single charge of powder and ball on such unremunerative game, which he could not sell and would be unable to eat.

The common crocodile, *Crocodilus palustris* and *C. porosus*, are found in most parts of India and Burma. These reptiles, although often termed man-eaters or snub-nosed croco-

diles, assist in depopulating the waters of fish, and it has appeared to me that it is only when they find an insufficiency in the finny supply and carrion that they turn their attention to man and the larger mammals. Every traveller in the East must have seen these logs of wood, as they appear to be, lying for hours at the sides of rivers or on rocks above the surface of the stream, and which sink so noiselessly into the current as almost to make one believe one's eyes had been deceptive, for how could anything so large have so quietly disappeared. In 1868, when at Cuttack, the crocodiles' appetites were not appeased by the fish they obtained, so they commenced consuming human beings, horses, and cows, varying their diet with an occasional goat or sheep. Doubtless, in large rivers, as the Ganges, these reptiles have their redeeming qualities, being the natural scavengers and consumers of carrion. Human beings are now no longer permitted to piously place their dying relatives by the side of the sacred stream, fill their mouths with mud, and leave them to be carried away by the waters or adjacent crocodiles; neither are corpses interred in the current of that holy river. If fish are insufficient, and the crocodiles are not to be destroyed, from whence are these reptiles to obtain their subsistence? The common law of self-preservation will induce them to feed on the cattle of the neighbouring country, or on such human beings as unwarily approach too near to the waters in which they reside. This is no fancy sketch, but I will merely adduce two instances that came under my notice in 1868. At Cullara exists a hole or pool in the Nuna River to which these monsters resort during the dry season, and a short time prior to my visit, they had succeeded in carrying off five adult human beings, while near the Baropa weir two women and one horse were taken by crocodiles in a single month.

Otters are likewise very destructive, especially in the hilly districts, and when they have exhausted the fish, they turn their attention to the frogs. In fact, the large frogs, *Rana tigrina*, are evidently considered great delicacies by these animals, for when kept domesticated they even seem to prefer them to fish. In some rivers, as the Ganges and Indus, the porpoise, *Platanista*, is a large fish consumer.

When mentioning animals which compete with man in destroying fishes, there are some families that must not be omitted, although I only propose casually to allude to them. Birds which eat fish are exceedingly numerous, not only in the true swimming and wading forms, but even the Indian pee-wit may be observed in the dry months, taking its share of the smaller examples of the finny tribe that are more or less exposed to view in the drying-up pools. Snakes luxuriate in irrigation canals, and revel in luxury at the bases of the larger weirs. In that across the Coleroon, when the water was low, I was plainly able to see these reptiles lying in wait for the fishes attempting to ascend. I should suppose I never saw less than twenty any evening I examined this weir on its down-stream race. Tortoises and turtles are fish-consumers, while most fishes prey upon their weaker neighbours or their eggs. Near Ganjam, a native official informed me how he had ventured out one night to see how murrul—the walking fishes—were captured. The fisherman was provided with a long flexible bamboo as a rod, and as a bait used a live frog. Hardly had the frog splashed into the water, when a moderately-sized murrul seized and swallowed it. Desirous of observing what would next occur, the fish was left on the hook, as a bait for anything else. Before long, a large water-snake was seen swimming towards it, and soon had the fish enclosed in its capacious jaws, and in this fashion all three were pulled together out of the water. Frogs appear to relish fish-eggs, and to be by no means averse to devouring the fry occasionally.

Considerable discussion arose upon this subject in India, some high officials suggesting that a falling-off in the quantity of fresh-water fish is no reason for legislative interference, unless it could be demonstrated that a danger existed of annihilation. The Viceroy summed up the question in the following suggestive sentences:—"Is the present plan of non-interference likely to ensure to future generations the fullest possible supply of this food staple? Is it even such as to ensure their inheriting a supply equal to that which now exists? The Governor-General in Council apprehends that both these questions must be answered in the negative, and that not only is there no prospect, as matters now stand, of an increased supply hereafter, but that, owing to the absence of precautionary measures and reasonable restrictions, the existing supply is diminishing."

Before concluding this portion of my paper, I must refer to an experiment which has been made in India for the purpose of protecting fisheries. If no destructive waste was existing

prior to the commencement of protective measures, no augmentation of the fish would have become apparent; if, however, very beneficial results have ensued, there does not appear any reason why such should not be extended elsewhere. In South Canara, Mr. H. S. Thomas observed that it may be doubted whether poisoning rivers or the wholesale destruction of fry is most injurious to fisheries; while prohibiting the finer and closely-woven bamboo cruives has been that the most ignorant, and therefore the most obstinate opponents, have been convinced by the testimony of their own senses, and have exclaimed, to use their own words, "truly the river is everywhere bubbling with fry;" and, what is still more to the point, their practice has not belied their words, for they have taken to fishing on grounds that were before considered profitless. Two years' discouragement of poisoning, and one year's discouragement of fine cruives, has worked such a change that it has been demonstrated, beyond cavil even of the ignorant and of the most interestedly opposing, that marked advantage can be reaped from the adoption of these two simple measures alone.

What measures have been instituted in order to mitigate the condition of the fisheries I have been unable to ascertain. Sir Richard Temple says, "No result worthy of note." An Act (VII. of 1875), however, has been passed for Burma, for the protection of the fisheries; while Mr. Buckland, Member of the Revenue Board in Calcutta, remarked (November, 1879) that the following figures show the progress which is being gradually made at Goalundo, at the confluence of the Ganges, and Burhampootra, where hilsa fish abound:—Fish cured 1875, 1,362 maunds; 1876, 4,835; 1877, 10,800; 1878*, 14,000. He concludes that "there is, therefore, some reason to hope that Dr. Day's proposal may bring some good fruit after a while."

Before passing on to the sea-fisheries, I propose considering what proportion of the people of India and Burma use fish as food, or, rather, can do so without infringing caste prejudices?

In the Punjab, comparatively but few of the inhabitants are prohibited by their religion from consuming fish, but there are many Hindus who reject it, as well as the rural population of some districts. But of those residing in towns, and in hilly ranges, it appears that, if the Brahmans are excepted, the consumption of fish is only limited by the paucity of the supply and the cost of the article. In Sind, fish is generally eaten by the population of the province, whether Mussulman or Hindu, unless a Brahman. In the North-West provinces, containing about 28,000,000 of population, out of twenty returns received from native officials, seventeen give more than half of the people as not forbidden by religious scruples from eating fish. In Oudh, the majority of the people appear to eat fish, but the supply is unequal to the demand. In the Bombay Presidency, the majority of the inhabitants of the inland districts are consumers of fish when they can procure it. In Haiderabad, Mysore, and Coorg, more than half the population are fish consumers; in South Canara, 89 per cent.; in Madras the majority, the exceptions being Brahmans, goldsmiths, high-caste Sudras, the followers of Siva, Jains, &c. In Orissa, more than half the people; in Bengal proper, from 90 to 95 per cent.; in Assam and Chittagong, almost the entire population; and in Burma, in the form of *nga-pee*, its use is universal.

As Buddhists, the Burmans profess a religious horror at taking the lives of lower animals, but being immoderately fond of fish diet, they console their consciences (while indulging in it) with the idea that the deaths of those animals used by them as food must be laid to the account of the fishermen, and cannot in any way be attributed to the consumers' fault. The walls of their temples have pictures of the terrible tortures the fishermen will have to endure in a future state of existence. In some of these interesting representations are large fires being stirred up by devils, while other evil spirits are dragging more fishermen in nets towards the burning fiery furnace, helping on some by striking fish spears into them from behind, and hauling them forward by hooks and lines towards the place of punishment.

But it may be asked are these Poongees' (priests) practices in accord with their teachings? By no means, as the following example will show. At Yahdown, on the banks of a branch of the Irrawaddi, a fisherman (Een Thoogyee), built a *Kyoung*, or monastery, as his great hope was to be termed a *Kyoung taga*, or founder of a monastery, a highly-prized title amongst the Burmese. Poongees came, and Poongees went away, but they did not care to remain, and partake for any lengthened period of the hospitalities of their host and disciple. At last one old priest appeared, who seemed to consider the quarters

* This shows an increase of 1,043,215 lbs. of fish in a year in one locality, where in the first of the four years nearly 112,073 lbs. were prepared.

as desirable. To him, in great trepidation, the owner put the following question, "Why, my father, do not the Poongees approve of my monastery, for none but yourself have remained over the going down of two suns?" "Because, my son," replied the holy man, "do you not break the law by depriving fish of life?" "True," he answered, "but were I not to do so, how could I supply your table with fish, or how could I live were I to give up my employment?" The only reply he could obtain was, "Better to fast while keeping the law, than to feast whilst breaking it!"

With sorrow the disciple took the priest at his word, and for three days refrained from fishing, giving his preceptor merely vegetables for his diet. On the fourth morning, when the same fare appeared, the Poongee observed, "My son, when you fish the river, does your net extend all across, permitting no fish to escape; or is a portion of the river free for those which select to pass to one side?" "Not all across, but only one-third of the way," he answered. "Well, then, my son," said the priest, "I have been seriously considering the subject, and have arrived at the conclusion that, if you leave room for the fish to ascend or descend the stream, and they will not avail themselves of it, but rush headlong into your net, the fault is theirs and not yours. Even Gaudama blessed the hunter who met him when he was hungry, and supplied him with venison. This was accounted as a meritorious act, although he must have killed a deer to obtain it. So go, my son, and procure me some fish, for I am hungry." From that day the priest consumed his fish in quietness, and refrained from inquiring from whence it had been procured.

Investigating how the local markets were supplied with fish up to 1873, the replies from native officials gave the following results. In the Punjaub one in ten markets were sufficiently supplied, in the North-West Provinces one in three, in Oudh one in four. In Bombay the amount was stated to be insufficient in all, and the same reports came from Haiderabad, Mysore, and Coorg. In Madras, near the sea, the quantity of fish was sufficient, but only in one in ten of the inland markets. In short, merely one-tenth of the bazaars were reported as fully supplied with fish, and of these one-fifth obtained them from the sea coast.

Fisheries, to a more or less extent, exist in the Indian Ocean, as well as up the mouths of the larger rivers, in backwaters and estuaries; while parallel to certain places, especially along the coasts of the Madras Presidency, vast mud-banks are present in the sea, having such a thin consistence that many kinds of fish are able to obtain abundance of food there as well as a suitable locality in which to deposit their ova. The most casual observer cannot fail to perceive how numerous are the varieties and vast the number of the finny tribes in the seas of India, but from some cause—whether due to the legislative enactments and local obstructions, or native apathy and impecuniosity—the harvest has, up to within the last few years, been comparatively untouched; an enormous amount of food still remains uncaptured, while famines are devastating the contiguous shores.

Want of space must be my excuse for not entering upon the various forms of fishes which populate the seas of India, and I pass on to their economic uses, for there well-stocked fisheries should be exceedingly valuable, as affording an inexhaustible supply of animal food, not only to persons residing in their vicinity, but also inland, should means exist to transport such in either a fresh or salted condition. The extent of the sea-board of India and Burma has been estimated at 4,611 miles; the fisheries are uninfluenced by recurring droughts, and ought to afford an inexhaustible harvest of food along the entire coast of the country.

Irrespective of mere food, maritime fisheries ought to be serviceable directly, as producing isinglass, fish-oils, and manure; or indirectly, as necessitating materials for the building of vessels, the manufacture of nets, hooks, and lines, the carriage of produce, &c. The modes adopted for utilising fish as food along the sea-coasts of India and Burma may be considered under (1) fresh fish, how far it can be conveyed inland; (2) dried fish and its varieties; (3) cured or salted fish, and how prepared.

How far can fresh fish be conveyed inland? In examining this question, if the employment of ice or salt is omitted, the distance sea fish can be carried inland, while fresh, depends upon several circumstances. The season may curtail this, as during the hot months putrefaction commences very rapidly, while some forms, especially the immature, the herrings, and the siluroids, decompose more quickly than others; and the same result follows close packing, or want of protection from the full force of the sun's rays. Usually, fish are not landed until after

sunrise, while those brought on shore of an evening are generally kept where they are until the next morning, coolies being averse to travelling after dark. On the other hand, facilities of carriage may exist, as railways, water communications passing inland, or arrangements made for this purpose. As a general rule, inland places having no special facilities for carriage do not receive uncured sea fish in a wholesome condition upwards of ten miles from the beach where they were landed. Should, however, the fish be first opened and cleaned, some salt rubbed in, and care taken in their conveyance) as warding off the sun's rays), they may be safely carried considerably further. But salt being very expensive is very seldom employed for this purpose, or else a very slight amount is used, and putrefaction has often set in prior to the fish being disposed of for human food.

What varieties of dried fish exist in India? Due to reasons which will be subsequently given, it has become the custom along the shores of British India, which are subject to the salt tax to its full extent, simply to dry fish in the sun. This can be done with smaller and thinner forms, as *Ambassis*, *Equula* the Bombay duck (*Harpodon nehereus*), many of the herrings and small varieties of immature forms, but not with the larger fish; however, even from these last, slices may be cut and sun-dried. In some localities small fish are first buried in the sea-sand, in order to obtain a little saline substance, and subsequently sun-dried. In damp weather such articles rapidly decompose, while in the hot months they are attacked by innumerable insects.

Lastly, how are Fish Salted?—The processes employed are chiefly divisible into the two following:—(1) Those cured with monopoly salt, or salt which has paid the Government tax; and (2) those prepared with salt-earth, or spontaneous and untaxed salt. It must be here remarked that I have very little information as to what changes have been effected during the last five years, but I believe a slight (5 or 10 per cent.) import duty has been collected on salt-fish landed from foreign ports, while the salt-tax in Sind, Bombay, and Madras has been increased to a very considerable extent. I propose first referring to salt and its cost, for wherever the fisherman or fish-curer can obtain this condiment at a cheap rate, there marine fisheries flourish; where it is dear, his occupation is destroyed, except for the purpose of supplying daily wants, and a little surplus for salting or sun-drying. This will be most easily explained by referring to the different districts in detail.

The amount of salted and dried fish exported by sea from Indian ports was as follows (the value is given in £, computing one rupee at two shillings):—

Five years ending	From Sind. Value in £	From South Canara. Value in £	From Malabar. Value in £	From Coromandel Coast. Value in £
1857-58 ...	8,472	no returns	no returns	no returns
1862-63 ...	13,064	,,	26,272	,,
1867-68 ...	18,725	6,969	48,207	1,753
1872-73 ...	22,944	14,921	90,849	4,513

The duty on salt in Sind was 2s. a maund of $82\frac{2}{7}$ lbs. avoirdupois, sometimes less, during the entire period comprised in the above table.

The first great increase in salting fish occurred in 1860-61, in which year the duty was raised in Bombay from 2s. to 2s. 6d. a maund. The next spurt of this trade, in Sind, was in 1864-65, when the salt-duty in Bombay was again raised from 2s. 6d. to 3s. a maund. Possibly the importations into that Presidency from Sind would subsequently have been more, but Government decided, in 1867, to admit all salt-fish from foreign ports, where no salt-duty exists, into British India free of duty, to the immense advantage of the Portuguese settlements and the Meckran coast, but completing the ruin of Indo-British fishermen and fish-curers, unless they were advantageously located.

In olden times, salt was allowed duty-free in British territory, for salting fish; but this enactment was repealed (year not ascertained), because the excise officers considered that it assisted smuggling.

The Table on page 624, being returns from different districts on the west, or Malabar coast of Madras, shows the annual sales of Government, or monopoly salt, along with the value of the salted and dried fish, which were exported by sea.

The Table shows that the amount of annual exports of salt and dried fish in Western India had very little, if any, connection with the quantity of monopoly salt which was disposed of.

In the native state of Cochin, the sale of salt in ten years, ending 1872-73, owing to augmented duty, was reduced by two-thirds, while it was during this very period that the great increase in the amount of exported salt-

Years.	South Canara.		Cannanore.		Tellicherry.		Travancore and Cochin.	
	Fish. Value in £.	Salt Sold. Maunds.	Fish. Value in £.	Salt Sold. Maunds.	Fish. Value in £.	Salt Sold. Maunds.	Fish. Value in £.	Salt Sold. Maunds.
1863–1864 ..	1,057	191,002	96	11,653	1,459	72,505	5,416	728,268
1864–1865 ..	3,036	168,279	219	7,932	1,504	57,516	6,052	643,897
1865–1866 ..	875	184,174	11	9,856	194	62,135	7,061	672,370
1866–1867 ..	1,124	151,113	12	9,728	1,825	57,381	7,337	497,988
1867–1868 ..	875	174,629	303	8,721	2,011	56,502	7,803	558,766
1868–1869 ..	114	176,465	520	9,045	4,319	63,340	7,130	573,639
1869–1870 ..	2,053	147,173	4,340	8,807	5,839	72,616	6,096	574,119
1870–1871 ..	3,927	136,967	1,470	7,932	5,309	57,624	5,833	593,389
1871–1872 ..	2,845	177,482	695	12,008	5,340	88,674	6,987	577,268
1872–1873 ..	5,980	135,839	951	6,985	8,429	77,332	?	?

fish began. In the contiguous British district of Chowghaut, although in the year 1872 £1,067 8s. worth of salt-fish were exported, only £46 worth of monopoly salt was disposed of. The cause of this is susceptible of an easy explanation. Owing to some flaw in the land or revenue laws, or else due to an immemorial custom, it was ruled that the people might collect salt earth, in order to cure fish for their own consumption; while, there being no law restricting their disposing of any surplus they possessed, a large trade in selling such sprang up. Consequently, fish-curing did not require a large capital to commence with. This induced an increased demand for fish; the fishermen's trade became well paid, and an immensity of animal food found its way into the market which would otherwise have been lost. That this is the correct explanation is shown by examining the state of the fisheries on the eastern coast of the Madras Presidency at the same period. There the right to gather salt earth is not recognised, but, observed one official, the practice of salting fish must be increasing, considering that the price of the fish, which formerly cost 2s., has been reduced to 1s. 3d. or 1s. 6d. This reduced value of the fish was doubtless due, not to the increased prosperity of the fishermen, who were evidently in a miserably poor state, but that the absence of salt wherewith to cure fish had diminished the demand for the article, and fishermen had to be content with a lessened price. The Madras Revenue Board* (May 14, 1873) observed that the fishermen numbered throughout the Madras Presidency 394,735 persons; that the answers elicited by the questions put by Dr. Day, &c., have directed the attention of the Board to the subject of the influence of the salt duties on the trade of fish curing, and they see reason to think that a great practical hardship exists, which they would advocate immediate endeavours to alleviate. A small amount of fish is prepared with monopoly salt in Madras,* especially for local consumption and export to Ceylon; but the amount of this condiment employed by fish-curers cannot be great, as it makes no perceptible figure in the amount of salt disposed of. In Bengal, the excised salt appears never to be employed for fish-curing, and the fisheries are in a neglected state; or, as observed by the collector of Balasore, "Fish sold in the markets are so stale that no European would touch it, and most of it is putrid. . . . The people in this district do not salt their fish, they dry it in the sun, and eat it when it is quite putrid. They like it in this way, and there is no reason why it should be interfered with. Salt was then (1870) subject to a duty of ten shillings for 82²lb. weight. Further to the eastward, in Burmah, the salt duty was one shilling for the same quantity, sun-dried fish a rarity, the fisherman's trade flourishing, while salt fish or crustacea, in the form of *nga pee*, invariably formed part of every meal among the indigenous population.

It will be necessary to remark upon the amount of salt which must be employed in order to properly prepare a given quantity of fish. In Sind 20lb. of monopoly salt is

* One of the members of the Revenue Board at Madras, writing to me on November 8th, 1882, observed, "The industry (of salting fish) is really commencing at last: 400 tons more were salted this year than last, and 80 more yards for curing are to be opened in a month or two."

* The salt tax in Madras in 1859 stood at 2s. a maund, but has since been raised as follows:—1859-60, 2s. 9d.; 1860-61, 3s.; 1864-65, 3s. 4½d.; 1869-70, 4s.; 1875, 6s.; now 4s.

added to 82⅞lb. of fish; on the western coast of Madras, as Tellicherry, 28lb. of salt is used to 82⅞lb. of small fish, as mackerel, herrings, etc. It appears that, for the purposes of trade, one part of monopoly salt is necessary to about three parts of fish. However, at Gwadur, in Beloochistan, where this condiment is very cheap, a larger proportion of it was used than in either Sind or in India. Fish cured with salt earth, or spontaneous but untaxed salt, require a much larger amount of this antiseptic than they do of monopoly salt, or nearly three (upwards of 2½) parts of salt earth to one part of fish. This cost of salt, it will be perceived, must have a bearing upon the state of the fisheries; where it is cheapest (other things being equal) the fisherman's trade will be most developed. Along the coasts of Beloochistan, where there was no salt-tax (1873) large communities were entirely supported by fisheries, their captures being cured and exported for the Indian or Chinese markets. The same remark applied to the Portuguese settlements of Goa, Daumaun, and Din, the salt used there costing about threepence per 82⅞lb. weight, whereas in the contiguous British territory it stood at the salt-pans at about four shillings. Hence the foreign fishermen were able to freely use this condiment; the cured article was preserved in a superior manner, more wholesome to the consumer, and able to be carried further inland. In short, fisheries thrived along the Beloochistan coast and the Portugese settlements, due to the excise on salt, being not excessive or entirely absent. In the Bombay Presidency, the fisherman's market became restricted to the sales for immediate consumption, or else for sun-drying, or, as the collector of Tanna observed, "Whether fish is dried as above, in preference to its being salted, is a question I have been unable to ascertain. It is very probable that it has been resorted to in the place of curing by salt, consequent on the excise duty levied on salt." Wherever salt earth could be obtained free of duty, along the western coast of Madras, there the fisheries thrive, the fish-curer requiring a large supply of fish. Along the east coast of Madras, the collection of salt earth was more or less prohibited, and the fisherman's trade, except near large towns, not very flourishing. But in Bengal the fisheries are, or were, worst off, the only curing fish obtained being sun-drying. Lastly, in Burmah, where salt is cheap. the fisheries were thriving. Before concluding this portion of my subject, I would observe that it is not to be supposed that fish cured with salt earth are of the best quality; on the contrary, it imparts a bitter and unpleasant flavour, and is believed to engender disease. But the poor cannot be particular respecting the taste or smell of their food—the cost is the important question Salt earth costs about ½d. a basket of 144lb. weight, depending upon its quality; but, as I have observed, it takes three times the amount that it is necessary to employ if excised salt is used. But 82½ lbs. of monopoly salt was taxed 3s. 7½d. at this time; now, 4s.; whereas 246 lbs. of salt earth cost from ¾d. to 1d., and this is the reason of the latter being preferred by fish-curers for the purpose of preparing fish for the trade; for if monopoly salt, at its present rate, were used, the article, at least to the general public, would be simply unpurchaseable. Fish are plentiful in the sea. The reason why the harvest remains ungathered is not due to the apathy of the fisherman, or the unwillingness of the general public to be consumers of fish, but solely a result of the heavy cost of salt, and that a consequence upon the Indian salt-tax.

Having briefly enumerated the fish which stock the seas of India, and how the fisherman's and fish-curer's occupations are injured by the incidence of a heavy salt-tax, I pass on to the fishermen and their condition, as it was a few years since. Doubtless, should no sufficient market exist for the produce of their industry, some of these people will leave fishing, and engage in other pursuits; while those who remain endeavouring to make a livelihood, as did their forefathers, will seek the cheapest way and easiest method by which such may be accomplished. A very little acquaintance with the habits of fish suffices to teach the fisherman that the smallest kinds are taken with the greatest ease; as, preferring the vicinity of the shore, and seeking their food in shallow waters, they are more readily captured in weirs, or with fixed engines and traps, than are the larger, more predaceous, and strictly deep-sea forms. But by disturbing the shore, and destroying or driving away the small fish and crustacea, the food is being diminished which previously decoyed the larger and more predaceous forms in, thus scaring away what would otherwise be the natural supply; and then it is erroneously asserted that the amount of fish has decreased. The fisherman's business is to supply personal requirements and family wants; consequently, if he obtains as much of the finny tribes as he can find a market for or otherwise employ, no

injury is inflicted by such a proceeding; because, so long as salt is not available (owing to its price) for the purpose of curing the surplus which may have been captured, meeting the small local demand for fresh fish is all that is really requisite.

The deep-sea fishermen—or rather, those who ply their occupation outside the shallow waters of the littoral zone—as a rule do so by means of nets, or with hooks and lines. Deep-sea netting is not carried on to any great extent, partly because of the insufficiency of a good market to render such remunerative, and likewise owing to the expense which would be necessary in obtaining the requisite nets, and the cost of building seaworthy boats. Fishermen are not to be classed among the moneyed classes, so have to borrow money, at exorbitant rates of interest, wherewith to supply themselves with the requisites for their work. As an instance, in Sind a net suitable for sea-fishing would involve the outlay of £40 or £50, while it does not usually last more than a year. A boat costs about £100, and ought to be serviceable for several successive seasons. The money having been borrowed, the fisherman who is the borrower disposes of the whole of his captures at half the market rates to the person who has supplied him with the money. Still this leaves a surplus, due to the existence of a good market for the fish-curer's trade.

The sea fisherman in most parts of the coasts of India assert that in olden times they were divided into two distinct classes — (1) those who captured fish in the deep-sea, or beyond their own depth; and (2) others who fished from the shore and in the backwaters and creeks. Now, owing to the depressed state of the fishing trade, the deep-sea fishermen (except where salt is cheap or a good market exists) have taken to the less expensive occupation of plying their work in-shore. In several parts of India, more especially in the Madras Presidency, they have customs of a patriarchal nature, but which are more strictly observed on the Coromandel than on the western coast. In Sind there are four divisions of the fisherman caste, each being under its own chief, who is hereditary, and his business is to settle caste disputes and other trifling matters, also to conduct the religious ceremonies connected with marriages and deaths. In the Bombay and Madras Presidencies, headmen to the fishing castes likewise exist; in some localities they are hereditary, in others elective; or should there be no headmen, matters are laid before certain wealthy individuals of their own caste, whose decision is final. In places where the fishermen are native Christians, the priest appears to be appealed to in order to settle disputes.

In olden times, the fishing castes held a much more important standing than they at present possess. Commanded by their own chiefs, they were ready to engage in military expeditions. The Samorin, in 1513, sent a deputation to Portugal, and his ambassador, who turned Christian, was knighted, under the name of "John of the Cross," by John III. On his return to India, he was banished from the Samorin's court, as a renegade from the faith of his fathers. In 1532 he joined the fishermen, and appears to have been installed as their chief, as he headed a deputation of eighty-five of them to Cochin, soliciting the assistance of the Portuguese against the Mahomedans. The whole of the embassy are said to have become converts to the truths of Christianity, so a Portuguese fleet was sent to their relief, and 20,000 are reputed to have immediately consented to be baptised. Ten years subsequently, Xavier instituted a church for these people.

It appears probable that the present organisation of the fishing classes is the remains of some ancient system, for on no other supposition can the existence of individuals holding an extensive sway be accounted for. The village or patriarchal system of an elective headman to such of his caste as inhabit each street and hamlet, is what is seen elsewhere among labourers; so likewise is the hereditary headman over several villages. But among the fishermen there exists priestly chiefs, two of whom are to be found on the Eastern coast, one being at Madras and the other at Cuddalore, the territory of the former stretching up the Coromandel coast, while that of the latter reaches towards Cape Comorin. A third is found in South Canara, where he exercises spiritual control over a large district, and it is by no means improbable that others may exist. These chiefs, whose offices are hereditary, claim or receive fees and fines from those of their caste living within their jurisdiction, and they are the final referees in all cases of caste or family disputes.

The next grade is also hereditary. These mere petty chiefs or headmen only hold sway each over a few villages; their duties are the same, and some of their fees seem to have to be transmitted to their superior. On one of these headmen dying without heirs, a new one is elected by the people of the caste. Lastly,

the fishermen have the elective headman, who is chosen by the residents of a single hamlet; his duties are to decide disputes, to be present at marriages and religious ceremonies, often to fix the work, and assist in certain Government duties; his emoluments appear to be very trifling.

Passing on to the condition of the fishermen (as it was a few years since) in Sind, they have to pay a tax of 10s. a ton yearly on their fishing boats, while the rate at which they borrow money for the purpose of procuring boats and nets I have already alluded to. Here these people are well off. At Guzerat, in Bombay, the fishermen are poor, and the precarious living they make often induce them to accept service as sailors, labourers, or anything that ensures them a steady competence. Although following out the condition of the fishermen in various districts must have rather a sameness, it will be necessary to do so in order to clearly see whether these people are really in a prosperous or in a poverty-stricken condition; whether, in short, it is the case that they are in the utmost misery, not due to their own laziness, but as a result of British legislation imposing prohibitory duties on salt, which is even now being made heavier and heavier, regardless of the ruin of these people, and the enormous loss of food to the inhabitants at large. In the Junjura district, the fishermen supply themselves with boats and nets; six or ten club together to obtain a boat and net, dividing the produce; here they have decreased in numbers. At Broach they are also said to have diminished. The same report comes from Kaira. In Rutnagiri the practice of salting fish has decreased during the last fifteen years, in consequence of the increase in the price of salt, but the fishermen are said to have increased. If, however, the practice of curing fish has decreased, while the number of fishermen has augmented, such must be due to a greater demand for fresh fish, or else the fishermen, from increased numbers, must be worse off than they previously were. However, the official from Kanara gives a similar reply. The commissioner observed that at present no larger number of men are engaged on fisheries than are required to provide sufficient for local consumption. The practice of curing fish has to a great extent diminished, owing partly to the falling off in the amount usually captured, and also the duty charged on salt in British territory.

In the Madras Presidency, we are informed that, in the Tinnevelly Collectorate, the fishermen, as a rule, are a very miserable lot of people, and excessively poor. The way in which they work is by a system of advances made by traders, a few of whom reside in each fishing village, and supply all the requisites for fishing, as well as the boats, taking one-third of the captures as their share. In the Nellore district, although no one claims exclusive rights to the sea fisheries, the inhabitants of the different villages are exceedingly tenacious in order to prevent fishermen from other localities plying their occupation within what they believe to be their limits. In the South Canara district, where the use of spontaneous salt is, or rather was, not prohibited, the number of sea fishermen is stated to have increased of late years. This augmentation has been computed as high as 15 per cent. The same symptom of prosperity was reported all down the Malabar coast. At Ponany there is an annual increase in the number of fishermen. At Cannanore the owners of boats and nets supply them to these people, as well as advance certain sums of money. The money-lenders sell the captures, half the proceeds going to either party; if, however, the take is insignificant, the boat and net owners surrender their share to the fishermen. A like plan obtains at Tellicherry, where the fishermen have framed rules for their own guidance, one of which is the right of the first discoverer, among a lot fishing together, to a school of fish: he is allowed to capture them without hindrance from the others, even though at the time when the fish were discovered he was not prepared to launch his net. Passing out of the districts where the free collection of salt earth is permitted, another change for the worse in the condition of the fishermen is reported. In Madura it is said that, on the whole, the sea fishermen have increased, but that the aboriginal fishing castes have decreased, owing to emigration or their becoming sailors. At Ootipadaram the native official estimates the daily earnings at threepence, taking all the year round, and excluding costs, and at Munjery at from three-halfpence to ninepence, while at Tenkarei their earnings are computed at from threepence to one shilling a day. In the Tanjore Collectorate, they are reported to have decreased in some places, but remained stationary in one locality. A little better report comes from Madras, but there the fishermen are also employed as boatmen, which is very profitable, while the vicinity of large stations affords a sale for fresh fish.

Without tracing out the condition of these people in each district on the coast, it will be sufficient to say that they are poor and miserable, but not so badly off as in the Bengal maritime districts, where they appear to be quite poverty stricken. Passing on to Burma with its cheap salt, we find the sea fishermen well off.

If we pass in review the reports from all the sea districts, we find the fishermen well off in Sind, while, unless in the vicinity of large towns, they are miserably off in the Bombay Presidency. Along the western coast of Madras, with its untaxed salt earth, these people prosper; but once round Cape Comorin, where the collection of spontaneous salt becomes a penal offence, they become, as observes the collector of Tinnevelly, a very miserable lot of people, and such is the same account all up the Coromandel coast, except where there are large towns. With poverty we find them reported to be decreasing in numbers, due to cholera or other diseases, emigration, or accepting service as Lascars in coasting vessels. These are a people who in olden times were among the most prosperous of the inhabitants along the coasts of India; who, when the Portuguese first landed, were able to bring large armies into the field; whose occupation is now thought unworthy of the care of the Legislature, except when it seems possible to impose new taxes on their industry, in the shape of an augmented salt-duty—as an European official remarked, that sympathy ought not to be wasted on fishermen, for they are an independent, careless, and drunken set of men. This gentleman, trained up in the latest school of political economy, I believe, merely placed on record what are the feelings of many who are unacquainted with the state of this trade, for by careless and independent he probably meant idle, which idleness is due, first, as I have already explained, to the incidence of the salt-tax; and, secondly, that when salt is unobtainable, did they exert themselves, the market would become overstocked.

Such is a brief outline of the fisheries of India, the part they subserve in providing food for the people, and the hindrances under which they suffer. Excellent and painstaking as are our Indian officials, there are but few among them who have time to interest themselves respecting the complex question of fisheries, while the fishermen are among the most patient of the races of India, and the least likely to bring their grievances to notice. It thus comes to pass that the philanthropist, with mistaken zeal, throws open fresh-water fisheries to the people, eventuating in their depletion or almost ruin. The legislator believes that permitting the fishermen to collect salt earth, or obtain salt duty free, will only be assisting the smuggler, and allows him no exemption. The financier, requiring money, sees in salt taxes the best means of obtaining it, and forgets, or perhaps never investigates into, how such is detrimental to the health of the inhabitants, and ruinous to the fisheries; while the high official who permits matters to drift as every chance wind blows, is merely following, in respect to fisheries, the example given in this country, where they are by turns cared for or disregarded, and every interest save those of the finny tribes have their advocates and upholders of their vested rights.

DISCUSSION.

The CHAIRMAN said they were much indebted to Dr. Day for the interesting paper he had read. With reference to some remarks towards the close of the paper, in which he described the disadvantages under which the fishermen of British India laboured, he might say that the question of the duty on salt used for curing fish had during the last few years occupied the very careful consideration of the Indian Government and of the Secretary of State in Council. Everyone felt that the fishermen were under considerable disadvantages by the salt they require for fish curing being taxed; but the difficulty has been to devise any plan by which they can be supplied with free salt without great risk of the illicit use of such salt in other consumption, and consequently without injustice to those who paid the tax. He hoped, however, that there was now a prospect of this difficulty being solved. The system of bonded enclosures, within which fish may be cured with free salt, has been tried at Madras, and it appears to be working so successfully, that it is hoped it will be found practical to introduce it to all other parts of British India.

Mr. EDMUND KIMBER said it had been clearly demonstrated by the paper that throughout India there ought to be some regulations for the preservation of fish. In England such regulations existed; and although in the county of Nottingham there were 150 societies for the purpose of fishing, they were all stringently bound by certain rules, and he believed there were only about six weeks in the year entirely open for all fish. So with the Thames; a gentleman of the City, Mr. Sprackley, spent about £200 in seeing that the fish in the Thames were only caught at proper times, and it seemed to him a great pity that there was not some philanthropist in India who would take up the same kind of action. Dr.

Day had alluded to the difficulty of obtaining ice, but he did not think that ought to be a difficulty much longer. In Calcutta, at the present time, ice was manufactured for 10s. a ton, and sold at £10 a ton; in Lahore, Multan, Delhi, and Agra, it was also produced at a similar rate. When the profits were so enormous, the natural consequence would be that the manufacture must be increased, and the profits diminished until the commodity became a general article of consumption. Here in London, in competition with the importers of ice, the General Ice Company were under a contract to supply 6,000 tons at 10s. a ton, although it fetched £2 to £3 a ton wholesale. He hoped this manufacture would be established in hundreds and thousands of places throughout India, which would meet many of the difficulties complained of.

Dr. ONDAATJE said it would be interesting to hear from Dr. Day whether, in his opinion, the eating of putrefying fish was one of the causes of leprosy. Again, he should like to know what were the substances used in poisoning the fish, and whether the fish so poisoned was unwholesome; thirdly, he would ask whether there were not certain fish which were considered poisonous at certain seasons, and if so, what was the cause. With regard to the Buddhists of Burmah eating fish, he might say that in Ceylon, Buddhist priests were strict vegetarians, and avoided eating fish in any form, though he had no doubt they occasionally partook of it *sub rosâ*. In Ceylon the consumption of salt amounted to nearly 7 tons per 1,000 head, while in India the rate was only about 3¼ tons per 1,000 head; the people of Ceylon were much better off than the people of India in this respect. The tax is Ceylon is Rs. 2 13a. per cwt. He would also ask whether the turtle was, at any particular time of the year, poisonous.

The Rev. J. LONG remarked that, whilst travelling last year in Norway, he visited several hospitals for leprosy, and was informed that that disease was mostly attributable to eating bad fish.

Mr. W. S. SETON-KARR said he could testify to the accuracy of observation which Dr. Day had displayed so far as regards the Province of Bengal, with which he was well acquainted. He could quite confirm what he said, that fully 95 per cent. of the population would eat fish if they could get it. Every tank, river, and stream swarmed with fish, and yet the recklessness with which it was consumed was a bad augury for the future supply. He did not think it would be possible to introduce a close season in Bengal, but he agreed with Dr. Day that something might be done to stop the indiscriminate massacre of fish by regulating the size of nets, and prohibiting some engines altogether. Fish were consumed in Bengal in a state which would be there considered unhealthy. According to his observation, the fish were caught by one set of men, and taken to market by another set, and on a hot day the smell of these fish was most offensive. The fish were most preyed upon towards the end of the hot season when the tanks were dried up. The whole population then turned out, men, women, and children, and caught them with baskets, cloths, and anything they could use for the purpose, and it was quite time something was done to stop this reckless destruction. With regard to the salt, something might be done to cheapen the price of salt; and of late years there had been a desire to equalise the salt tax all over India, and he had no doubt the Government would turn its attention to the subject.

Mr. D. S. WHITE (President of the Eurasian and Anglo-Indian Association) said he had just arrived from Madras, and a few days before he left, in a conversation with Mr. Whiteside, he was informed that the subject of fisheries was being taken into consideration by the Council. The question had been referred to Mr. Thomas, who was writing a report on the subject. It was a question whether the Government should introduce fishing smacks, or whether it ought to be left to private companies. He had not gone into this subject himself, but his own belief was that salt fish might be largely consumed, and that it was not consumed by the European population because it was not properly cured. If people were sent out to teach the Indians how to cure fish properly, he thought a large trade might be carried on.

Sir JOSEPH FAYRER, K.C.S.I., F.R.S., said he had had great pleasure in listening to the paper of Dr. Day, who was probably the highest authority upon that subject, which was one of great national and economic importance in India. They had been told by a very high authority with reference to Bengal what an exceedingly valuable article of food fish was, and that it would be eaten readily all over India, if the reasons assigned by the last speaker did not stand in the way, that it was so badly prepared. Dr. Day was not only a book naturalist, but a field naturalist, and had studied this subject practically, and the Government could not do better than take his advice upon the subject. It did seem strange that there should be an almost unlimited supply of food running to waste, whilst there was an abundance of the article by which it could be preserved and made useful, and yet the two could not be brought together. He would not offer any opinion upon the political and other aspects of the question, but there was the fish, and there was the salt, and surely something might be done to bring them together. As to the question of ice, in theory it was very good, but the idea of manufacturing ice all over India for the preservation of fish was simply absurd. Dr. Day had alluded to the many natural enemies of the fish, and he might say that he had often noticed those destructive creatures, the fish-eating crocodile, which must destroy thousands and tens of thousands of fish.

Some of these gavialis were from 18 to 20 ft. long, and had in their stomachs nearly half a bushel of pebbles, for the purpose of triturating the food which they consumed. He should be very glad indeed to think that the reading of this paper and the opening of the Fisheries Exhibition next month would form new points of departure with regard to the preservation of fish in India. Not many years ago it was found that the forests of India were being wasted and destroyed, but, by a little judicious interference, that had been stopped, and now vast quantities of timber were being raised. The same thing might be done with regard to fish, if those who had given attention to the subject were consulted, and their advice followed.

Mr. W. G. PEDDER said he could quite confirm what had been stated with regard to the reckless destruction of fish towards the close of the monsoon; in the rice districts of the lower provinces of Bombay, he had seen the fields full of small fry, and as the water drained off, they were destroyed. With regard to the suggestion that Government should take measures to put a stop to this destruction, he could only say the difficulties were very great; it was one thing to make a law, and another thing to put it in force. They might enact that the mesh should only be of a certain size, but how could such a law be enforced; it could only be by a constant system of interference and perhaps corruption. No one was more convinced than he was that what was done in regard to the preservation of forests was absolutely necessary, but at the same time the complaints throughout India with regard to it had been very great, and in some respects well founded. Only a few years ago, a very reasonable Bill was proposed in Bombay for the protection of game, and there could be no doubt the benefit from it would be very great; but, after consideration, the Government thought it would do more harm than good, and he feared something of the same kind might occur with regard to fish. Some rather severe criticisms had been passed on the way in which fish was preserved in India, but he thought nothing could be nicer than the famous little fish called the Bombay ducks, which were so preserved.

Mr. MARTIN WOOD said the last speaker had uttered a well-founded caution, which might be suitably taken into consideration as against the enthusiasm of Dr. Day, but still such a substantial case had been put forward by the latter, that something ought to be done. The result of what had been done by Mr. Thomas in South Canara was very gratifying, and he thought if it were fully explained to administrators in other parts of India, they might be inclined to repeat the experiment. What was still wanted to be known was the cost of what was done, and the exact results. He might suggest that, instead of imposing penalties, something might be done in the way of premiums and prizes to encourage the culture of fish. The most interesting fact about fish on the Bombay coast were the fishermen, who were hardy and industrious. Those on the Kolaba coast, south of Bombay harbour, were really a fine class of seamen. It did seem hard that by the existence of the salt duty, and other circumstances, these men should be prevented from doing the service they might do to the whole population. The salt duty was a heart-breaking subject. As it was now levied, it was an effectual prevention of any general distribution of fish, and the hardships imposed on the population by it were very great. No doubt there was a tendency to reduce the duty; but it must be remembered that the Finance Minister had just said something to the effect that he regarded the salt duty a financial resource. As long as that was the case, there was not much chance of its being reduced to such an extent to make it available for fish-curing purposes. Fishing was only one of many industries which were seriously crippled by the salt duty. The salting of fish in bond, spoken of in the paper, was a very ingenious idea; but did not strike him as a very practical one, because fish-curing was naturally very much of a domestic industry. The Chairman said it appeared to be succeeding very practically so far at Madras. Dr. Day had not alluded to the experiment recently attempted of importing the *gourami*, a fresh-water fish, into the Vehar Lake, the water supply of Bombay; but he should like to know whether it was likely to succeed. He could corroborate what was said by Mr. Kimber as to the cheap manufacture of ice in India, and there was no doubt fish could be transported hundreds of miles by its means. Curiously enough, though Mr. Kimber had spoken of the Calcutta and several other ice factories, he omitted to mention the very place where this new industry was first started, namely, Bombay.

Dr. DAY, in reply, said he had omitted several things in reading the paper, one of which was the point mentioned by the Chairman, of curing fish in bond. He had been asked to draw up plans for developing the fisheries of India, and this was one of the methods he suggested. Mr. Thomas had written him to say there was an increase of 4,000 tons of fish salted last year; and writing in last December, he said that next month he expected to open sixty more yards, so that it looked as if they were really doing something in Madras. With regard to the introduction of the *gurami*, it seemed to him that it was unnecessary to introduce fish from elsewhere, so long as no care was taken of those that existed, and that it was far better to preserve the native fish than to introduce other sorts from distant climes. It had been said that it was impossible to carry out an Act for the preservation of game in Bombay, but it certainly was carried out in other parts of India. There was an Act for the preservation of game in Madras, which worked very well on the Neilgherries and on the Himalayas. With regard to the effects of eating putrid fish, he might say, that for some years he was in charge

of the Leper Hospital, at Cochin, and he did not think there was the slightest doubt that badly cured fish was a cause of leprosy. This had been proved most conclusively in Europe. On the Norwegian coast, large quantities of fish used to come which were badly salted, and leprosy existed to a large extent. When the fish disappeared from one locality, leprosy also ceased; but it broke out in other places where fish became more plentiful. There was no doubt that large numbers of the population at Ceylon, at certain times, had been poisoned from eating a form of sardine, and an Act was passed in the time of Sir Emerson Tennent prohibiting the catching of these fish at such seasons; but recent inquiries had shown that it was much more likely that something else had caused the disease, for the Act was never enforced. In the West Indies over forty fish, especially those about the coral reefs, are known to be poisonous. On the Madras coast there are no turtles, therefore, the people could not be poisoned by them, but no doubt something they had eaten might cause them to be poisonous in Ceylon. He perfectly agreed that it would be hopeless to have a close season for fish in India, but certain regulations might be carried out which would have a similar effect. Fish existed in India to an enormous extent, and a slight amount of care would produce great results. Mr. Thomas simply stopped using fixed instruments and the poisoning of rivers, and in two years the result was wonderful. In Burmah, before the English took possession of it, every fixed trap placed in the irrigation fields was subject to a licensed tax, and in this way they were kept within bounds; the contractor of the district used to allow people to catch fish for their own consumption for a rupee a year, but not by traps or nets. Since the English had had Burmah, the whole of the rules with reference to fisheries were done away with, but he believed the Governor-General had been quite convinced that such was a mistake. Going back to the old histories of Madras, it would be found that all the tanks were kept in repair by the moneys received from the fisheries; at the present time nothing was got, and there were no fish. He did not see that any complaint could be made if we did not interfere more than the natives themselves used to interfere in this matter. He did not approve of the plan of the Government setting up fishing smacks in Madras; if the fishermen could get salt, there would be no difficulty. The reason the men did not work was because it was no use their catching fish which they could not cure and sell. There was an inexhaustible supply of food round the coast of India, which was now untouched, and it could only be utilised by the use of salt. Then came the question whether salt earth could not be made use of to a great extent, for he believed taxed salt would never be cheap enough to salt fish for general consumption. The salt tax was being equalised by being raised along the coast, and at 4s. a maund, it would never pay the fisherman to use it. The only other plan was to establish bonded warehouses, and he believed that was being taken up by the Madras Government. Ice might be employed very usefully in certain places, such as large towns, but those were the very places where it was not so much needed, the fish being all disposed of as soon as it was brought ashore. The places where fish could be advantageously salted, were down the coast, where there would be much more difficulty in establishing ice machines, and even then he did not think it would be very effectual without much better means of carriage.

The CHAIRMAN then proposed a vote of thanks to Dr. Day, which was carried unanimously, and the meeting terminated.

TWENTIETH ORDINARY MEETING.

Wednesday, May 2nd, 1883; WILLIAM HENRY PREECE, F.R.S., Member of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Dobson, George, Llanishen, near Cardiff.
Broadbent, John James, Stafford-house, Burney-street, Greenwich, S.E.
Watson, William, Derwent-hill, Keswick.

The following candidates were balloted for and duly elected members of the Society:—

Bain, Richard Donald, Stow-park, Newport, Monmouthshire.
Craven, Thomas Fewsdale, Birkby-house, Westbourne-road, Sheffield.
Monnery, Edward John, 165, Fenchurch-street, E.C., and Greenbank, Lingard's-road, Lewisham, S.E.
Wells, Frederick Arthur, Springfield, Chelmsford.
Wharton, Charles Joseph, 8 and 9, Holborn-viaduct, E.C.

The paper read was—

ELECTRICITY AS A MOTIVE POWER.

BY PROFESSOR GEORGE FORBES.

The subject of the transmission of power by electricity has been so often discussed in this room, that I have had some difficulty in selecting the point of view from which I should look at the subject to-night. I presume that most of my audience have seen the action of a current which was generated by one dynamo acting upon another dynamo so as to cause it to rotate. I presume that they have also seen

such a motor driving a circular saw, or a fan, or a sewing-machine. They may also have heard of the grand possibilities among which the imagination delights to revel, on the realisation of which we shall look back on the old life without electricity as being but one step removed from barbarism. I propose to myself something more humble, but, perhaps for all that, quite as useful. That is, to discuss the results which have been already attained, and to show what steps are immediately possible with the knowledge and experience now at our disposal. I will not weary you with descriptions of machines, nor refer to their relative merits. In quoting the performance of any special machine, it will not be so much on account of its merit, as because it may have come more especially to my notice in connection with the particular subject which I may be talking of.

Of course, from the moment that Oersted discovered the action of a current on a magnet, it was known that energy could be transmitted to great distances by a wire. The energy which is put in at one end of a telegraph cable is partially reproduced thousands of miles away, in the form of mechanical movement. But what we have to consider is, the condition of using a current to supply motive power to drive machinery. In what cases is such an application practicable, in what cases is it economical, in what cases convenient? I wish to give you, this evening, an answer to these questions, and to explain what has been done and is being done in this field; how far we can build on past experience, and how far we are justified in foreseeing steps in the future. When new discoveries are made, we are distrustful of them; but we are too often, also, apt to be over-sanguine, we dive, in our imaginations, into the future, and conceive that that immediately will be accomplished which experience ought to warn us can only be the result of many decades of labour.

Let me give you an example. We are constantly hearing at present of a certain method by means of which water-power, it is said, will be extensively used. This is to use it in charging accumulators with electricity, and then to carry the accumulators on a tramway or railway, and use them to drive the wagons. At first sight this seems very feasible, but reflection makes us pause. The same water-power has been always available: it might have been used to compress air; compressed air tramcars have been constructed, and, in my opinion, are a perfect success. This method of application of the water-power is much simpler than by the electrical accumulators. But it has not yet been tried, and hence we cannot hope that this method of using electricity is likely to be very soon introduced.

From the time that it was known that a current of electricity, in going through a wire round a rod of iron, converts the iron temporarily into a magnet, inventors have been at work trying to utilise this knowledge in the construction of motors. The chief difficulty lay in the very short distance through which the attraction of a magnet remains powerful. There was also, in the motors of old date, a difficulty of getting over the dead points. The length of pull of a magnet may be considerably increased by various devices. A somewhat similar action may be effected by utilising the suction of the current through a coil of wire upon a rod of iron. A coil of wire with a current through it acts as a magnet. One end of it attracts the N end of a magnet. But the coil also magnetises a rod of soft iron placed in this position, and, having magnetised it, it attracts it.

This principle has been utilised directly to obtain power from electricity. The most interesting application of it which I have seen, was at the Electrical Exhibition at Munich last year. That exhibition was especially of interest owing to the various applications of electricity as a motive power, and I shall have occasion to refer to it more than once. The machine to which I now refer is designed by M. Deprez, and is called an electrical hammer. It is intended to perform the same functions as a steam-hammer. It consists of a vertical tube containing a short rod of iron, and surrounded with a coil of wire. The wire at each turn is led away to a contact piece on a plate with a moveable switch. By this means, the current passes only through fifteen turns of the wire. But there are one hundred turns of wire altogether, and by moving the switch you can pass the current through any fifteen you please. You suck the iron into one section, and then move the switch, and so raise the centre of attraction. In this way you suck the iron up to the top of the tube, and then you can equally well drive it down, with the force of suction added to the weight of the iron. The weight of the iron was 80 lbs., the height of the tube one metre. I can illustrate the principle with this model. He used a current of about 36 ampères; 31 ampères was found sufficient, when passing fifteen times round, to support

the weight of the iron. The length of the iron rod was about six times its diameter. This is equivalent to saying that, in such a coil, a current of one ampère must circulate (15×30^2), or 13,500 times, to support the iron rod in the centre. I tried independently with this small coil, which has three layers of forty-three turns each (129 in all), and I found that five ampères were required to support the iron in the centre. From this result one ampère would have to make 16,200 turns in place of 13,500, as Deprez found. I give these data because they help to fix our ideas, and numerical measurements in magnetism are far more scarce than in electricity. Dr. Werner Siemens has used the same principle in the construction of a motor to be driven by electricity, though I need hardly say his invention was not derived from the one just mentioned. It will readily occur to you that the electrical hammer of M. Deprez might, by a simple modification, be converted into a reciprocating motor, like the piston of a steam-engine, and so it might be used to drive a fly-wheel and machinery. But in this mode of applying it, the whole of the momentum of the iron mass would be lost at the end of each stroke. The same is true of the piston of a steam-engine. But in the rotary-engine it is not the case. Now although the rotary-engine is not so economical as other steam-engines, its principle serves to lead us from the electrical hammer of M. Deprez, to the beautifully ingenious electric motor of Dr. Werner Siemens. If we suppose the tube with the coil of wire round it to be bent round into a circle, the iron cylinder being also bent into an arc of a circle, then, by changing the points of contact for the current to pass through the coils, we could suck the iron core round and round inside the circular tube. This is the principle employed by Dr. Werner Siemens in the elegant motor which he has lately produced. The inner iron core is made in the form of a complete ring, but only a certain arc is of iron, the rest is of brass. It rests on wheels, spaces being left in winding the coils for these supports to reach the central ring. In the actual machine, the points of contact for the current to enter and leave the coils are changed automatically by the rotating ring. In such a form of motor, the magnetism of the iron is never changed or destroyed, and this diminishes largely the waste of energy, by heating during magnetising and demagnetising, which is so serious an objection to most motors—I think I might safely say to all other motors.

If this form of motor were used to drive machinery, it is easy to see that, instead of making contact automatically, it would be quite easy to do so by hand, simply turning a handle round; and by doing so more or less rapidly, the speed of the machinery might be regulated by a boy with most perfect facility. It could be quickened, slowed, stopped, or reversed, by the simple process of turning the handle. I consider that there will be a great demand in the future for such a form of motor. I will give one example. I am sure many of my audience will sympathise with me when I speak of one of the horrors of a sea-voyage, I refer to the terrors of the steam-winch. What traveller has not spent sleepless nights under the constant influence of the whirring and jarring of that dreadful engine when stowing or discharging cargo. For many years I have felt convinced that this was a field for the application of electricity as a motive power. But for a long time no scheme suggested itself to me which was perfectly satisfactory. In fact, it was not until I saw Dr. Siemens's motor that I felt satisfied that the thing could be accomplished. I have no hesitation in saying that such a motor, with the contacts made by hand in the manner I have described, will be a very perfect machine, and very much more easily managed than the present steam-winch, with its troublesome combination of valves and brakes of multiplying and reversing gear. When such machines are introduced, life on board ship will be a different thing.

Now, I am not going to spend time to-night in describing all the different motors which have been invented. Most motors now in use are simply generators of electricity used in a different way. Many years ago, after a prolonged absence from England in the Pacific, I was writing to the late Professor Clerk Maxwell, and asked him what had been going on in science during my absence. His answer was, "the greatest discovery of late years is that a Gramme machine can be reversed." He saw that this must be a more perfect type of electro-motor than any previous one, and that now there was a real future for employing electricity as a motive power. The Gramme machine was a cheap generator of electricity, and was an efficient motor. The problem was solved, and only required development. Of course, Professor Clerk Maxwell's remarks would have applied to any other of the modern generators. I am not going to trouble you with a description of these machines; their con-

struction is known to most of you. It suffices to say that, when one machine is turned so as to give a current, it can drive another machine at a distance.

Now let me say a few words about the convenience of electrical motors. We are certainly a long way from having electricity laid on to our houses, like water, which we may use for any purpose we please. But when it is laid on, it is certain that many people will use it, because they now use water-engines, although water is very expensive, and because electric motors would be far more convenient in many ways. But in a large factory, the only methods available for distributing power is either by shafting or by steam-pipes. Both of these are objectionable in many ways, and the convenience of having only to lead wires to the different places where power is required, will in time become manifest to many of our manufacturers. This remark applies more especially to donkey-engines and steam-steering apparatus on board ships; and I confidently look forward to electricity being largely used for the light work on steamers, and this before any long time. Of course, special attention will be given to see that the compasses are not affected by the powerful magnets and currents used for these purposes.

It is found that to get any good effect an electric motor must run at a high speed. In this there is a great difference between the theory of electro-motors and of steam-engines. If a steam locomotive were restrained from running down an incline by the prsssure of steam on its piston, the steam would be doing no work, and no power would be used up, except by a slight condensation. But if an electric locomotive were to perform the same office, it would be using up the current all the time, and yet not performing external work. When with the electrical hammer the iron cylinder is supported in the tube by the electric current, power is being used up, and yet no external work is done. It is the same as with muscular exertion. This introduces us to a new factor in mechanics, the cost of the statical effort. When I support a weight, I am using up muscular energy, and yet I am doing no external work.

But there is one peculiarity in electric machines of great importance. The motor is also a generator. Thence it follows, that, when it is in motion, it creates an electromotive force. This tends to produce a current of electricity in the circuit, going in the opposite direction to the one which is driving the motor. The intensity of this opposing force is directly proportional to the velocity of rotation. If the generator and motor were identical, and the work done by the motor was so far reduced as to allow it to rotate nearly as fast as the generator, then the opposing electromotive force would almost be equal to that of the generator, and there would be hardly any current in the circuit. But if a brake be put upon the motor, more work is done, and the current in the circuit increases. The maximum amount of work is got from a motor in this way when the counter-electromotive force is equal to half that of the generator. The greatest efficiency (or return) is obtained when the counter electromotive force is nearly equal to that of the generator. Some persons have argued from this that we ought to run motors with very light loads for the sake of economy. This is not the case. If the motors were run so as to do only half of the maximum, we should require twice as many motors, and usually the prime cost of the motors is too great to cause this to be economy. The efficiency of a generator for electric lighting or other purposes is highest when there is a very high resistance in the circuit, but electricians, as a matter of fact, nearly always work their dynamos up to their maximum capacity, although this is by no means the most economical, so far as the efficiency is concerned.

I have said that, to produce a good mechanical effect with a dynamo used as a motor, it is necessary to drive it at a high speed. This speed is generally too great for ordinary mechanical applications. For example, we do not require the wheels of a tram-car to turn at anything like a speed of 800 turns a minute. In such applications, then, it becomes necessary to reduce the speed by suitable gearing. Thus, in the electrical tram-cars which have been constructed hitherto, belting has been used, or some equivalent. This is an awkward expedient, and one which, in practice, is found to give much trouble. I am inclined to think that, in making an electrical railway, it would be preferable to make the wheels of small diameter and attached directly to the axle of the motor. This seems to be by far the best plan in the present state of affairs. It may be that a motor will be found which will work economically at a lower speed; but with those which are now at our disposal, it would be best to work with very small wheels.

We now come to consider, directly, the

transmission of energy to a distance. There are two separate kinds of application. One is to fixed motors, the other to locomotives. Let us begin with the stationary motors. There is no doubt that if electricity be capable of transferring the water-power of rivers to the centres of mechanical industry, if it be capable of introducing economy by burning coal at the pit mouth, or the bottom of the pit-shaft, then we have a vast engineering industry ready to open out.

It is not until we have sat down and worked out from experimental data the cost of installation and maintenance, that we can pronounce an opinion on the merits of such schemes. When we want to send a large quantity of energy to a distance, through a thin wire, we must use the highest electromotive force which we consider safe, and the most powerful current which the conductor will bear without either fusing or injuring its supports by heating, and then we have no means of increasing the amount of energy which we can send, except by increasing the size of our conductors. Unfortunately, when we double the weight of our conductors, we do not double the current which we can pass through them. Hence there must necessarily be a limit to the quantity of energy which can be sent along a single line, which limit is reached when the cost of the conductor becomes too great. When a limit is thus attained, the only way of increasing the transmission of energy economically is by increasing the number of systems of conductors, or else by introducing means of cooling the conductors. These are the considerations which have guided M. Deprez in his experiments. But Sir William Thomson has shown that the loss of horse-power in heating the conductor more than compensates for the expense of thicker conductors. For economy, we ought to have the value of horse-power thus wasted equal to the value of interest and depreciation of conductors.

In such an installation we require to consider not only the quantity of power which can be transmitted, but also the efficiency of the arrangement. Now the efficiency varies with the quantity of power which is transmitted. If we transmit very little energy, we get a high efficiency, nearly = 1; if we transmit the maximum amount of energy possible, the efficiency is $\frac{1}{2}$. In fact, the work done by the motor is proportional to the efficiency minus the square of the efficiency—

where $w = 4M(e - e^2)$.
M = the maximum work possible.
e = the efficiency.
w = the actual work returned.

and consequently, when the efficiency is nearly equal to unity, the work done is zero. It is found in practice to be preferable to get nearly the maximum work out of a machine, rather than to increase the size and cost of the machines, in order to get a certain amount of work from the apparatus.

Of course, it is only after long experience that we shall know what is the maximum power which we can send along a wire, and what limits must be put to the electromotive force which we use. M. Marcel Deprez has spent much time and labour on making practical tests of this nature. One of these formed a chief attraction at the Munich Exhibition last year, where he used an iron telegraph wire 4 mm. diameter (or a sixth of an inch), and transmitted $\frac{1}{2}$-horse power to a distance of $35\frac{1}{2}$ miles. He has since been carrying on experiments of the same kind at Paris The results have lately been published, and I shall return to them.

One of the chief things which I proposed to myself, when I was asked to read a paper here, was to give some account of the experiments which I saw at Munich. I was very much struck indeed with the transport of energy by Mr. Schuckert, of Nürnberg, not that there was any new principle involved, but I had never before seen so much as five or six horse-power conveyed by a thin wire so far as three and a-half miles. The power was derived from a turbine, at Hirschau, beyond the English gardens. These turbines are employed on a locomotive factory, no steam being used in any of the shops. They have thus 260-horse power at their disposal. The machine at Hirschau was of a larger size than the motor in the exhibition. This is a point on which Mr. Schuckert has made careful experiments. This machine, which was driven by the turbine, worked a number of agricultural machines during the day, and served to light thirteen Pilsen lamps at night, both being in the exhibition building. The turbine being a very large one, and revolving slowly, transmitted its power to the dynamo by belts. A turbine is a very convenient motor for a dynamo, for it happens that, when we are using a dynamo requiring the whole power of the turbine, the proper speed for each is nearly the same, so that the dynamo may be attached directly to the shaft of the turbine, which is, of

course, a very great convenience, and a saving of power. In my experiments, in conjunction with Dr. Young, on the velocity of light, at Wemyss Bay, I made use of such an arrangement for producing the electric light. A small Siemens machine was attached directly to a Thomson's vortex turbine with horizontal shaft. The water was led from a distance of nearly a mile. The convenience of being able to start the electric light by merely turning a handle was very great indeed, and I can recommend this arrangement to anyone who has water-power at his disposal.

But to return to the Hirschau installation. A pair of No. 7 copper wires conveyed the current, one-eighth of the E.M.F. being wasted in heating the wire. This installation, taken as a whole, was much to be admired. I do not say that there was anything new or much information to be gained from it, but it showed to every one visiting the exhibition a good working practical installation. Mr. Schuckert has been good enough to give me the results he has obtained from two experiments with different sets of machines. All the four machines with which these experiments were made are constructed for generating a current of eight ampères. In one experiment the generator was constructed for fifty-five incandescent lamps, with a motor constructed for thirty-three lamps (the lamps being in compound parallel). In the other he used as generator a machine for about 150 lamps, with a motor made for eighty-eight lamps. The particulars of the machines are given in the following Table, from which we see that in each case 36 per cent. of the energy put into the generator was reproduced as work done by the motor :—

	First Experiment.	Second Experiment.
Type of generator	TL 3	TL 5
Type of motor	TL 2	TL 4
Difference of potential—		
(1) At terminals of generator	300	700 volts.
(2) ,, ,, motor ..	260	600
Resistance of leads	6 ohms.	12 ohms.
HP. spent on generator	4·4	12·8
HP. given by motor.....	1·6	4·7
Efficiency (per cent.)	36	36

I give you these figures, not because they show any wonderful performance, but because it is desirable to have as many facts as possible when any new idea is being developed.

You see that, in these experiments, the aim has not been so much to get a high efficiency as to get a high amount of power developed. This is what ought always to be done, while the machines form the chief item of cost.

Let us now speak of the experiments of M. Marcel Deprez. In 1881, M. Deprez published the theory of transmission of energy to a distance, by means of a thin wire. It is a theoretical fact that, if you get a certain return by using a given generator and a given receiver, and with a certain length of wire between the two, you can double the distance with the same results as to power, using the same thickness of wire, if you construct a new generator and a new receiver wound with smaller wire, so as to have double the resistance of wire wound, the other dimensions of the machine being unchanged. This had been known before, and the theory had been fully worked out by Frölich and others. But Deprez had the credit of working out numerical examples, and of afterwards putting the theory to the test of experiment. In his first paper, he started with some experiments made at Chatham, in which two Gramme machines were used, one as generator, the other as receiver, when, through a line-resistance equal to that of either machine, a return of 50 per cent. was obtained. He then showed that theoretically a similar pair of machines could be constructed so as to transmit 50 per cent. of the energy to a distance of 100 kilometres, an ordinary telegraph wire being used, 4 mm. thick, giving a resistance of 9 ohms. to the kilometre. He also stated that 12-horse power being used by the generator, 6-horse power would be delivered by the receiver. I do not consider that the theory in this paper was quite clear, but the main point was proved.

After the publication of this paper, the Munich Exhibition was a thing of the immediate future, and M. Deprez was invited to make his experiment with a distance of sixty kilometres. The resistance of a telegraph wire of this length, using the earth for the return, was 475 ohms. Consequently, two machines were made of the normal type, like an "A" Gramme, each of 453 ohms resistance. These machines developed very high electromotive forces (about 2,000 volts), and when they were installed, it was naturally discovered to be impossible to use the earth as a return. Consequently, another wire was used, increasing the resistance to 950 ohms. This militated against the complete success of the experiment, and I think it is unfortunate that, in their desire to assert the success of the experiments, the friends of M. Deprez withheld this fact from the public, and so led many people to believe that the theory was inexact. As a

matter of fact, owing to the great resistance of the line, 60 per cent. of the total electric effect was used up in heating the circuit, instead of 40 per cent., as had been calculated. In order, then, to get a satisfactory return, it was necessary to allow the receiver to do very little work. Thus, in the trial made by the committee of experiments before the machine broke down, only 0·433 of a horse-power was utilised at Munich, and there was a return of 39 per cent. of the power put into the machine at the distant station of Miesbach.

These experiments were of a very high degree of interest, and M. Deprez deserves the thanks of scientific men for the zeal he showed in carrying them out. Let us see, now, whether an economy would thus be introduced by burning coal at the pit mouth, and transmitting power, as in the Miesbach experiment. Allowing 3 lbs. of coal per horse-power per hour, if we work twenty-four hours a day for 300 days in the year, we have almost exactly 10 tons of coal per horse-power per annum. Suppose the coal costs 5s. a ton at the pit mouth, and ½d. per ton for transport over the kilometre, it follows that the cost of furnishing 0·433 of a horse-power at Munich by transport of coal would be the cost of 4·33 tons of coal, and their transport over 60 kilometres, amounting to £1 11s. 6d. The cost of coals to work the machine at Miesbach, with a duty or efficiency of 39 per cent., would be £2 19s. Let us assume the machines to cost £100 together, then, neglecting the cost of the telegraph wire, and allowing 15 per cent. for interest and depreciation of the machines, neglecting also the extra cost of the larger steam-engine required at Miesbach, we have an annual expense of £17 19s. for the power delivered electrically at Munich, against £1 11s. 6d. for the same power delivered by the transport of coal. Even if the machines cost nothing there would be a loss; if the power cost nothing, there would also be a loss. It is folly to use machines costing so much only to produce ½-horse power.

I have no doubt that M. Deprez could have got more than a ½-horse power at Munich, but had he attempted this it would have been at the cost of efficiency. It cannot be too constantly borne in mind that, in electro-mechanics, you can increase your efficiency almost up to unity, but at a sacrifice to the total amount of work transmitted. But it must also be constantly remembered that you increase your total work up to a certain maximum, but at the cost of efficiency. The maximum efficiency is obtained when the load is so great that the motor is only just able to turn round. The efficiency is greatest when the load is so light that the motor turns nearly as quickly as the generator. I repeat that an erroneous idea has been promulgated that we ought always to run motors at a speed approaching to this condition of maximum efficiency. But if this be done, the return of work is insufficient to pay for interest and depreciation on the plant required.

The very important experiment of M. Deprez at Munich, is able to give us much information for future use. Among other facts, we learn that, with machines of the type described by him, 2,000 volts is too high an electromotive force to employ. The reason is that it is impossible to prevent the contact of the brushes from being sometimes accidentally broken. In such a case it was found that the electromotive force developed by the extra current is sufficient to ruin the insulation.

Another matter deserving of attention is the relative size of the generator and motor. M. Deprez employed two machines of equal size. This slightly simplifies the theory, but it is certainly not the most advantageous arrangement, and we are much in want of accurate measurements on this head.

From what has been said, it is clear that the Deprez experiment at Munich was, commercially, a failure. You might, at first sight, think that if a thoroughly scientific experiment like this was a commercial failure, there are no cases in which it would be a commercial success. This is by no means the case. Since the time of the Munich Exhibition, M. Deprez has been occupied with experiments of a far more practical nature, with a line of 160 ohms resistance. In the latest experiments, where the effects of friction were deducted, a return of 47½ per cent. was obtained, and 4·4-horse power of work was actually given off by the motor. Judging from the Hirschau experiment, I should say that if a fall of water be used as the motive power, we can install a turbine and dynamos which shall transmit 6-horse power through a resistance of 12 ohms, at a cost of £200, neglecting the unknown cost of the conductor. If this power were used in a place where coal costs 20s. per ton, the cost of fuel for 6-horse power would be about £60 per annum. The interest and depreciation on the boiler and steam-engine would be about £30 per annum, making in all £90 per annum, exclusive of wages. Electrically transmitted, the interest on plant, at 15 per

cent. would be £30 per annum, exclusive of wages. This difference of £60 per annum, after deducting from it the interest and depreciation of the conductor, is so enormous, that it is easy to see what a large saving would be effected in any installation where there is a large consumption of power. There are many factories where it is essential to use a high priced coal, but if the power could be conveyed electrically from a distance of a few miles, an immense saving would be effected by employing a cheaper kind of coal. When water-power is used, it often happens that we can convey the cables along the bed of the river. This preserves the insulation, and keeps the conductor cool, so preventing the usual increase of resistance by heating.

In some towns, and notably in Sheffield, the whole of the water supplying the town comes from reservoirs at a very great height. The very large quantity of energy of this water is at present absolutely wasted; and although coals are not dear in Sheffield, and manufacturers are permitted to burn the most smoky kinds of coal in the centre of the town, yet the employment of this waste water-power would add very considerably to the commercial prosperity of the town, and the water would be injured in quality no more by passing through turbines than by passing through the present pipes. If this power were distributed electrically, the benefit to the community would be great indeed.

At the site of the Severn Tunnel there is a width of river of two and a-half miles, where the average rise of tide is fifty feet. If the average rate of flow across this section were one mile per hour, we could utilise 100,000 horse-power, and the market value of that power is something like £1,000,000 per annum, which is now allowed to be wasted. It is worthy of the most serious consideration whether it would not be worth while to erect the enormous engineering works which would be required to utilise this wasted energy, or rather a portion of it. Assuming the interest and depreciation on the turbines and dynamos to be at the rate of £2 per annum per horse-power (and it would be far less than this for a large installation), it is easy to see that a time will come when this source of wealth will not be allowed to be wasted.

I wish to draw special attention to this point, because I have frequently heard people say, with regard to the utilisation of the tides, "Oh! that is out of the question: Sir William Thomson has proved that the area required to produce 100-horse power is so great that it would be more worth while to reclaim the land and cultivate it." Now Sir William never said such a thing. It is true that at the York meeting of the British Association, he showed what area would require to be enclosed in order to produce 100 horse-power on the supposition that there was a rise of tide of only 6 feet 7 inches (2 metres). And he made use of the following expression:—"Thus we are led up to the interesting economical question, whether is forty acres . . . . or 100 horse-power more valuable." But in the case I am considering, the height of the tide is six times that contemplated by Sir William, and the question is rather "whether is forty acres or 600 horse-power more valuable." The estimate I made above, as to the value of a horse-power, agrees with Sir William's; and the value of 600 horse-power is £6,000 per annum. I confidently state that the reclaimed land on the Severn would not be worth £150 per acre per annum. I have taken the site of the Severn Tunnel as an example, but there are many other places available, and I have little doubt that the industrial population at Bristol will soon realise the wealth of power at their doors.

Some people, in this country, are timid about the introduction of large turbines. This, I need hardly say, is a gross prejudice. At Connecticut, Massachusetts, 30,000 horse-power is derived from the river by turbines. At Narva, near St. Petersburg, one firm uses 12,000 horse-power, and the size of the turbines used, which were made at Augsberg, was limited only by the size of the tunnels on the railways by which they had to be conveyed. At Munich I saw 260 horse-power rendered available by means of turbines with a fall of less than two metres. In the remote valleys of Italy there are several installations of incandescent electric lighting by means of turbines driving the machines of Messrs. Crompton. In Scotland, too, we have powerful turbines. Mr. Pirie, the paper-maker, has introduced, near Aberdeen, turbines working up to nearly 1,000 horse-power. At Greenock large overshot wheels are employed. The Shaws Water Worsted Company are now replacing one of these, of 200 horse-power, by a turbine. In Lancashire water-power is also extensively used. At Valserine, on the Rhône, a canal has been cut through the rock, a third of a mile in length, thus giving a fall of about 12 metres and many hundred horse-power, using Jonval turbines. It is proposed to use the falls at Bellegarde, near Geneva, in the

same way. The Manville Cotton Company, at Albion, R. I., use turbines, with a fall of 5·4 metres, which takes the place of a steam-engine of 800-horse power, and economy is materially gained, although during the five months of the dry season they are obliged to use steam. At the Pittsburg Mill, Minneapolis, there is a Victor turbine, working up to 1,400-horse power, and another is being added of the same dimensions. These are only a few examples to show how thoroughly practical economical and convenient the use of turbines has become. We can with them calculate on utilising 75 per cent. of the theoretical power of the head of water. They can be controlled with the utmost ease. Their cost is very small compared with water-wheels, and they can be geared directly on to the shafts of dynamos. As an example of their adaptability to the purposes of the electrician, I may mention the performance of a Fourncyron turbine established at St. Blaise in the Black Forest, which utilises a fall of 108 metres, turns at a speed of 2,300 revolutions a minute, and gives off 60-horse power.

The engineering works which would be required on the Severn would be very simple, though on a large scale, and the action could be made quite continuous, independently of the state of the tide, and without any necessity of using accumulators.

Having now spoken of the applications of electricity to stationary engines, let us see what has been done, and what can be done, with respect to locomotives. There are two ways in which this application has been made. First, by storing the electricity in accumulators, and putting the accumulators in a tram-car, a boat, or a tricycle, and second, by deriving the current from a wire or other conductor placed along the line. The experiments made upon the first plan are very interesting, but their practical value is limited, owing to the weight and expense of the accumulators. I think that it would be far more economical to use compressed air engines. Ever since 1875, when I examined the compressed air tram-car of Scott Moncrieff, which ran so successfully in Glasgow, I have felt sure that this must become eventually the motive power for tram-cars, and I have not yet seen anything to lead me to alter my opinion.

What has been done in the second way of proceeding? We will see that considerable progress has been made. At the Berlin Exhibition in 1879, Messrs. Siemens and Halske drove a train of a few carriages round a circular tramway, the gauge being three-quarters of a metre. In April, 1881, the same firm constructed the Lichterfelde and Berlin electrical railway, which is two miles long. One of the carriages of this railway was shown at the Paris Exhibition of 1881. The current is passed through the rails, which are insulated. It is then taken up by the wheels, and so passed through the motor. The motor turns at a very rapid rate, but it is geared to the wheels of the carriage by belting of wire-rope, which reduces the speed of revolution. The carriage has the appearance of an ordinary tramway-car, and the machinery is invisible. It was expected that snow might prove troublesome in such a system where the current is passed through the rails, but the winter of 1881-82 was so mild as to give no trouble. I have not heard whether any difficulty presented itself during the past winter. At the Paris Electrical Exhibition a somewhat similar car was used, but Messrs. Siemens were not allowed to pass the current through the rails, on account of the danger to horses, &c.; hence they were obliged to carry conductors, consisting of split tubes, on telegraph poles, and a small carriage fitting into the tubes made electrical contact with the motor on the car. Another electric railway has now been completed by the same firm, between Charlottenburg and Spandauer Bock. In this case, also, a contact carriage is used, as at Paris. This line is three and a-half kilometres long; two and a-half kilometres are level, but this line is specially interesting from the fact that a whole kilometre is on the considerable incline of 1 in 28. Messrs. Siemens have also applied the same principle to haulage in mines. A small electrical locomotive is used in a mine near Dresden to drive eight corves loaded with coal. Finally we have the electrical tram-car running on the Portrush line, in the North of Ireland, but this has been so well described in this room, and so recently, that I need only mention it.

It has always seemed to me that the principal advantage which would be gained by using electricity as a motive power for railway trains, lies in the great facility with which motive power could be applied to every wheel of the whole train. Captain Douglas Galton, in the concluding paragraph of his report on experiments conducted by himself and Mr. Westinghouse, on continuous brakes, says:—"The advantage which thus evidently ensues from utilising the adhesion of every wheel of a train, suggests the further consideration as to

whether it would not be a more scientific arrangement, as well as being more economical in regard to the permanent way of railways, to utilize the adhesion of every wheel of a train for causing the train to move forwards, instead of depending for the moving force upon the adhesion of one heavy vehicle alone, viz., the locomotive."

Certainly, there can be no doubt that it would save the permanent way from tear and wear, and the passengers from the shocks which are so unpleasant. But it is only by means of electricity that the proposition is practical. Moreover, the moveable parts of a locomotive are not perfectly balanced, and this limits the speed at which it can go. With an electrical motor the balance is perfect. By utilising a motor on every wheel, you could go safely round curves at far greater speed. I feel sure that in this way it would be safe for trains to go at double the speed they do at present, and I hope to live to travel from London to Edinburgh in three and a-half hours, smoothly, and without jolting. Furthermore, a train, instead of taking several minutes to get up full speed, could do so in a few seconds. This follows from the same reasoning as is applied to continuous brakes. Lastly, if there were power enough, a train could go up a steep hill instead of being confined, as practically they are, to an inclination of 1 in 80. In a district with heavy goods traffic, this might be a great advantage.

These considerations appear to me to be so important, that I must pause a while to make them clear.

First.—As to getting up speed quickly. With an ordinary train, weighing ten times as much as the engine, the theoretical minimum of time required to get up a speed of thirty miles an hour is one minute, however powerful the engine may be. The reason is that the wheels would slip if the motion were accelerated more rapidly. But if power were applied to every wheel, it would have a speed of 30 miles an hour in six seconds, and with no more jerk than is now felt when a continuous brake is applied.

Second.—As to the going up hill. The same advantage here is gained as would be gained by continuous brakes. An ordinary train, when the lines are in an average condition, slips down an incline of 1 in 50, when the locomotive alone is braked. You all remember the sad accident the other day in the Rocky Mountains from this cause. But when all the wheels are braked, the train rests on an incline of 1 in 5. So also, if we had the power, we could ascend an incline of 1 in 5 by electrical motors.

Third.—As to advantage to permanent way and speed. The engine does not give a steady pull at all times to all parts of the train. In fact, in going round a curve, part of the engine's power is used up in trying to pull part of the train off the lines. With power applied to all the wheels, this would not be so. Moreover, the enormous weight of the locomotive, imperfectly balanced, which is the chief source of mischief, would be done away with.

Fourth.—As to cost. The cost of making an ordinary railway line with tunnels, embankments, bridges, viaducts, &c , in England, may be taken at £15,000 a-mile; but if it goes up inclines instead of having expensive engineering works, the cost will be the same as making it on a level, *i.e.*, £5,000; and hence, on a goods line, the cost of construction might be reduced to one-third. This original outlay is a far more serious matter than the working expenses of a railway (of which the cost of the traffic is 26 per cent.); so that, even if by using electricity you increased your working expenses, you might still be making a great saving on the whole. On fast passenger trains, the power to drive your trains at twice the speed would counterbalance any small loss of economy. Again, there would be a great saving in the cost of maintenance of permanent way.

There are many cases where such an application of motive power would be peculiarly satisfactory. The most important of these is the Underground Railway in our City. It is now universally admitted that steam locomotives vitiate the air to an intolerable extent. If motive power were used electrically, this evil would be avoided. Moreover, a line like this, which is almost totally underground, and is comparatively unaffected by snow or rain, possesses exceptional advantages for electrical insulation. But the system which I have advocated would introduce special advantages to this line. What are the conditions of working? The distance between stations is so short that a great deal of time is wasted in getting up speed and stopping the trains. The latter evil, it is true, has been reduced to a minimum by the adoption of continuous brakes; but you will understand how much speed is limited by the former consideration, when I tell you that an ordinary train cannot get up a speed of thirty miles an hour until it has passed over a quarter of a-mile, just about the distance between some of the

stations. If the system I propose were adopted, of applying motive power to every wheel, the same speed would be attained in forty-four yards.

The Channel Tunnel, when completed, will be specially favourable for the insulation of conductors. But the system which I recommend could not be adopted, as the great advantage of the tunnel is that the same waggons will go right through without any transference of goods. In this case, if electricity be used as the motive power, it would be necessary to use it to drive a heavy locomotive.

I think I have now said enough to prove that a great deal has already been done, and that we may reasonably expect a great deal more to be done in the use of electricity as a motive power. Water-power has been usefully employed in various installations to obtain electricity, and the current has been successfully conveyed several miles, to be reconverted into motive power with great economy, and electric railways have been successfully and economically worked at several places. I have not thought it right in this paper to indulge in Utopian dreams of what may be done in the future, however pleasant such an exercise of the imagination might have been. I have thought it to be more useful to look at the matter from a practical point of view, and to estimate our present position with respect to this force, and to indicate the steps which our past experience would warrant us in taking in the immediate future. I should like to see a larger number of our wealthy compatriots experimentalising in this field, so as to keep our country in the front rank of the applications of electricity, as she always has been in those of steam. But we must go on step by step—learning from every fresh experiment, and utilising experience for further advances. We must not hope to reach perfection at one bound. The development of this most potent of agencies must, in the nature of things, be gradual. We must have patience, but at the same time we must work and labour to our utmost, and take a step onwards wherever that step is sure, and in due course we shall be ourselves astonished at the progress which has been made.

"We have not wings, we cannot soar,
But we have feet to scale and climb,
By slow degrees, by more and more,
The cloudy summits of our time.

The heights by great men reached and kept
Were not attained by sudden flight,
But they, while their companions slept,
Were toiling upward in the night."

DISCUSSION.

The CHAIRMAN said this subject, although it had been brought before the Society on two or three occasions recently, had to-night been presented with a freshness which added greatly to the interest of the paper. The principal feature seemed to him to be not so much the application of electricity to trains, as the utilisation of the vast energy which was now wasted. The observations on the ease with which electricity would enable a train to get up speed, reminded him of a statement which Sir Frederick Bramwell recently reported as having been made by Captain Shaw viz., that some of the men in the Fire Brigade could jump from a height of 20 feet. In doing so, they must go at a faster rate than an express train, and yet they stopped instantly; and, if this were so, he did not see why there was any difficulty, with the aid of electricity, in getting up a speed of thirty miles an hour in six seconds.

Lord ALFRED CHURCHILL said he was not long ago called to account by the Chairman for venturing to prophesy that railway trains were not likely to be propelled with advantage by electricity, but he did so in the belief that the requisite speed could not be attained on long journeys. He admitted then that trains could be propelled with great facility on the Metropolitan Railway, for instance, or for other short distances, and after the explanation which had been given to-night, the question seemed to open out still more widely. The advantage of communicating rotary motion to every wheel in the train was, no doubt, very great; and if the heavy weight of the locomotive could be reduced or done away with, that again would be a great gain; but still there were many difficulties in the way. The cost of abolishing the present system, and introducing a new one, would be very great, and, as he understood, the stations could not be very far apart. At Portrush the distance was six miles, but if one took five miles as the average distance, there would require to be about eighty stations between London and Edinburgh. Then at each of these stations he apprehended it would be necessary to have duplicate dynamos, in order to provide against accidents, because it would never do to stop the whole traffic while one was being repaired. There would also be the difficulty that the line could not be repaired, as it was at present, by taking out a worn rail and putting in a new one between the passing of two trains, because this would break the circuit. It was very desirable that water-power, and especially the tides, should be utilised wherever possible.

Mr. J. N. SHOOLBRED remarked that the question of transmission of power and the most favourable construction of machines was at present receiving a large amount of attention, and many valuable experiments had been made by M. Deprez and by Dr. Fröhlich, of Berlin. It was very generally stated that a net result of 50 per cent. was the best attainable, and

Sir Wm. Siemens had given it as high as 60 per cent., but M. Deprez's experiments pointed to a less result even than 50 per cent. It had been suggested, however, that the use of such small conductors and high resistances, under the conditions described, might perhaps account for the smaller efficiency. He was glad to see that attention, which seemed for a time to have been entirely absorbed by the application of electricity to lighting, was now being devoted to the transmission of power, and important practical results could hardly fail to ensue. One point—viz., the importance of having what was termed the "characteristic" curve of a machine—seemed to be now acknowledged to be of great value; and another was the question of the statical charge. He did not quite follow what was said about Schuckert always using a larger machine for the generator than the motor, and he should like to know more definitely what was meant by a larger machine. Sometimes a smaller machine, of more suitable construction, was found to work better as a generator than a motor; it depended a great deal on the internal construction of the machine. The question of utilising tidal energy was one often mooted, and in vain; but by means of electricity there seemed some chance of taking advantage of it, at not too great a cost. The great difficulty hitherto had been the enormous expense of making storage reservoirs; possibly this might be avoided in the Severn; but he did not take quite such a roseate view of the results to be expected as Professor Forbes. There could be no doubt of the great advantage which would attend the application of motive power to all the wheels of a train, instead of, as at present, to a single motor (the locomotive), at the head, both on the score of dead weight, and as to increased efficiency in brake power.

Mr. SPAGNOLETTI said this subject was one which had been practically worked out by very few, and it was difficult to get at any real practical experience. The railway in Berlin worked very well, but the ground was particularly favourable, the soil being all sand and very dry; and it was a serious question whether, under ordinary circumstances, sufficient insulation could be obtained if the current were carried through the rails. The system adopted in Paris was quite different, and that seemed to succeed also, but he feared that with a long line the friction of the little carrier would be so great as to impair its efficiency. The principle of applying power to each wheel was excellent if it could be done, but the difficulty would be to ensure regularity. If anything happened to one carriage, and the power were not effective, there would be a certain amount of danger in having one carriage in front pulling it along, and another behind pushing it. In working trains engineers never liked to have a heavy engine behind a light one. He feared it would be rather difficult to introduce railways with heavy gradients, even if there were power enough to get up them, on account of the danger involved in going down.

Mr. GUMPEL said he had been somewhat disappointed to find the paper was really on electrical transmission of power, rather than on electricity as a motive power, but still it had proved very interesting, and contained useful information. He did not consider that Deprez's electrical hammer was a new invention, as Dr. Werner Siemens brought out one two years earlier, substantially on the same principle, but dropped it, seeing that it could not be much more than a toy. Again, the motor which Dr. Siemens exhibited at Southampton, was really nothing but an application of a principle which was shown in the Paris Exhibition of 1867; it consisted of a non-magnetic circular tube, surrounded by insulated coils of wire, the ends of which, from each section, were brought to the centre. In this tube was contained an iron bar, and by means of brushes attached to the centre of the commutator, the current was conveyed to the coils, and thus magnetism was produced, and the piece of iron was caused to rotate. This preceded the Gramme ring, and was described in several papers. Mr. Forbes had repeated a statement which was made some time ago by Dr. Silvanus Thompson, to the effect that Professor Clerk Maxwell had stated the greatest scientific discovery in the last 21 years to be the reversibility of the Gramme machine, but he could not imagine how he could have made such a statement, since the law of induction, as applied to all electrical generators, was enunciated by Lenz, in 1834, viz., that when a wire through which a current was passing was brought near to a conductor, a current was induced which made the conductor move away from the wire, and in that simple principle the whole reversibility of Gramme was included. He could show a publication issued in 1851, describing an induction machine, constructed by Storer, of Dresden, which was brought forward as a motor, and which was reversible. With regard to the experiments of Marcel Deprez, even *La Lumière Electrique* and *L'Electricité* admitted that there was a great deal of sensationalism about the whole affair. Deprez had the merit of having sent half a horse-power through a telegraphic wire; but this was brought before the workmen of Sheffield, in 1879, by Professor Ayrton, who told them that the only way in which power to any extent could be transmitted through a small wire, would be by using a machine of high potential; the real question in the transmission of power being the size of the conductor. To convey the power of Niagara to California was quite possible, but the question was whether there was copper enough in the world to form the conductor. Deprez had solved the problem to a certain extent, but his first statement, that an efficiency of 68 per cent. was obtained, was at once pronounced by Hospitalier, and others, to be impossible, and it was afterwards reduced to 38 per cent. To his

mind, the application of electricity as a motive power, meant not the transmission of the power of water or steam, but the development of electricity by chemical means, and in that direction, he believed, lay the hopes for the future. If ever electricity were applied on railways, it would be because instead of burning 10 lbs. of coal under a steam-engine, and getting a utility of one only, they could burn 1 lb. and get 90 per cent. of the energy in a battery. Electricity would then really become a motive power, and would soon come into general use.

Mr. RECKENZAUN said they had been told by Professor Osborne Reynolds that, theoretically, 1 lb. of lead, on being oxidised, would store up 360,000 foot-pounds of energy; and, practically, it would, in a storage battery, give out 50,000 foot-pounds. Compressed air had been compared with accumulators, but its efficiency was not nearly so great. With steel cylinders of the best construction, it would require a weight of about 100 lbs. to store the million foot-pounds, but with accumulators and a suitable motor, 40 lbs. weight would suffice for the same result. This was not merely theoretical, but had been carried out practically, and there was now a boat on the Thames which stored 7-horse power for seven hours, and the accumulator, which consisted of 8 lbs. of lead, practically gave out 45,000 foot-pounds.

Mr. SCOTT MONCRIEFF wished to make a remark or two on the importance of tractional force being obtained by attaching the motive power to each set of wheels. On the first occasion when his compressed air tram-car was tried, the wheels were not coupled, and it then went up an incline of 1 in 20. It followed that the present improved car, in which both wheels were coupled, would ascend an incline of 1 in 10. Professor Forbes said 1 in 50 was the limit on railways, and that might be so in the case of the ordinary guage, and where long trains passed at high speed, but he believed there were cases where much steeper gradients were used. If, however, the motive force were to be applied to all the carriages of a train, it would not get rid of the difficulty of sharp curves and centrifugal force in going round them; and, therefore, if Professor Forbes's anticipations of speed were realised, it must be accompanied by a great reduction in the sharpness of curves, or he feared the passengers would be landed in the neighbouring fields. Nevertheless, it would be a great point gained if, by means of electricity, the enormous weight of our locomotives could be reduced. When a paper was last read on this subject, in speaking of the comparative economy of electricity and steam, he had given rather too high an estimate of the efficiency of coal in stating it at 2 lbs. per indicated horse-power; but it was not so far from the mark as some of the speakers thought. The question was by no means cleared up, but he believed experiments would shortly be published, showing that something under 3 lbs. was not too low a figure for a well-constructed locomotive. Speaking as a layman on the subject of electricity, he could not help thinking that the future progress of electricity in transmitting the energy, either of natural forces or of coal, would be in the direction of much higher tension in the generator, and lower velocity. At present, successful working seemed to depend on low tension, and very high velocity, but, as a mechanical engineer, it seemed to him there must be great disadvantage in these high velocities, from the wear and tear of the various parts. If it were true that electromotive force was a mere conversion to another form of energy, it seemed to him there was a great future for electrical engineers in dealing with a force such as that of the tides, in which an enormous tension was available combined with low velocity.

Mr. BLAKESLEY, referring to the formula which Professor Forbes had given of efficiency, said he believed he had published the same thing, though different symbols were used, in the *Electrician* for November 18th last. A more important point was the question of M. Deprez's experiments and theories. He did not think people in England were generally aware of the discussion which was going on abroad with regard to them. It was Deprez who had propounded that theory of characteristics, which in its practical application was of the greatest possible importance. The theory was that the electromotive force of a machine was—other things being equal—proportional to the product of the velocity, and a certain other quantity, and he declared that that other quantity did not involve the velocity of the machine, from which he drew very important deductions. He, however, did not think this was correct. Having investigated the figures given by a good many experimenters, he felt quite sure that the velocity of the machine had an immense effect on what had been well called the effective magnetism, which was the factor into which you had to multiply the velocity to get the electromotive force. In some experiments of Dr. Fröhlich, the machine gave a current of about 58 ampères, and, according to Deprez, the magnetism ought to have been the same, but he found it was altogether different. With a current of 58·4 ampères and a velocity of 313, the magnetism was proportional to 629; with a velocity of 493, 601; and with a velocity of 601, it fell to 576—the current being practically the same. This demonstrated that the velocity had a considerable effect upon the magnetism. Deprez's theory of characteristics, that one can be derived from another by merely proportioning the ordinates to the velocities, rested upon this idea, that the magnetism did not involve the velocity, and he believed this idea to be quite erroneous. A practical result would be that the effective couple in a machine would be constant when the current remained the same, for this, which

M. Deprez calls the *prix de l'effort statique*, was proportional to the magnetism × current; but if the magnetism involved the velocity, as he believed, this couple would not be always the same for the same current.

Mr. Story Maskelyne, M.P., F.R.S., said this was a technical subject of which he had little practical experience. The paper, in fact, dealt entirely with the transmission of power by electricity, but that was the form in which electricity was to become the slave of man in the future. Of course the term motive power might be used in that sense; and every transmitter that produced motion might be called a motive power. What had been shown was that all the different ways of producing what he might term a resilient engine, which should take in energy at one time and place, and give it out at another, the best and most economical was by converting it into electricity. It might be done either by sending the force at once along a wire, or by using accumulators. One of the things he tried to elicit, when sitting on the Committee on the Electric Lighting Bill, was the safe limit of electric potential which could be used in a wire. The result seemed to be, that the tension to be allowed for the safety of the public was much below that claimed by the gentleman who wished to utilise the extraordinary high tensions which had been spoken of. If electric energy could not be safely transmitted through a thin wire, there was a great obstacle in the supply of copper, that being practically the only metal which could be used. One thing, however, seemed evident, that we were not much longer to waste those enormous powers of nature which were, so to say, sapping the vitality of our old world, by checking its career through space, and which we had hitherto so little used. Heine, in one of his poems, speaks of the beating of his heart as the hammer of a workman who was fashioning his coffin, and so preparing for his final rest. That was exactly what was going gradually on with the great pulse of the world—the tides; they were, little by little, slowing our progress through space, lengthening our day, and gradually bringing the world's motion to its end; and if by any means we could utilise this force (and a good deal remained to us!) so much the better. He did not know whether the tunnel-locality which had been mentioned in the Severn was the most appropriate for the experiment, but he believed the tide rose even higher between the narrow banks of the Wye at Chepstow, and they shared with the Bay of Fundy some of the highest tides in the world. If the immense force of the tide in the Thames could be utilised, it would supply London not only with light, but probably with all the power it required for the industries which were carried on in this great city. The only means of utilising this waste force seemed to be by the aid of the last-born of the sciences, the one which was making such vast progress, while the others might be said in comparison to be looking on. He would conclude by proposing a vote of thanks to Professor Forbes for his valuable paper.

Professor Forbes, in reply, said he should think the number of stations required between London and Edinburgh would not be more than twenty altogether; but these were matters of detail which they were hardly prepared for just yet. He agreed that the rails would not be suitable conductors; probably a special system would be introduced. The first introduction of electricity on railways would probably be in such places as the Underground Railway, where there would be such enormous advantages both with regard to getting up speed quickly, and the saving of noxious vapours. It was undoubtedly the case that an efficiency of 50 per cent. was most economical where you got the power for nothing, because then you wanted to get the most power you could out of the machine; but in cases where it was desirable to convert fuel into power, it would be something over 50 per cent.; it all depended on the relative cost of power, and the interest and depreciation on the plant, which was the most economical mode of working. Mr. Shoolbred had asked about the size of the machines; he was speaking of systems in which only one type of machine was used, and the size of the machine depended on the current, and the electromotive force it was made for. In transmitting power, the same current went through both machines, but the electromotive force required between the terminals of one was very different to what it was between those of the other, so that the actual electromotive force was very different, and necessarily, therefore, the motor should be a smaller machine. With regard to the difficulty of coming down inclines, if you had power enough to go up, the same power applied as a continuous brake would enable you to go down safely; by closing the circuit, the motors would act as a continuous brake, and in such a way as to prevent skidding. Several remarks had been made by Mr. Gümpel on the question of priority, and, as to that, he could only say, that having had a great deal to do with such questions, he was always very cautious in dealing with them, and, on such an occasion as the present, preferred not to go into them. He was obliged to Mr. Blakesley for drawing his attention to the formula he had published, which he would be glad to inspect. He would rather not discuss the merits of M. Deprez further at present; no doubt there had been a great deal of sensational writing about some of those experiments, but he had no doubt that, in the end, scientific men would take a just view of the matter. The question of the connection between the magnetism and the speed of rotation was very interesting, and if time had allowed, he should have gone more fully into it. An interesting proof of it would be found, if when a dynamo was in rapid rotation, you tested the armature of one pole which was farthest behind the direction of rotation; hardly any magnetism would be found there; it was carried rouud just as the lead was. Mr. Story Maskelyne seemed to think it was

very sad that the tides were stopping the earth's motion; but they might console themselves with the thought that nothing serious would happen in their time. He was quite aware of the fact, but he would warn Mr. Maskelyne that, in making use of the tides, we should be accelerating the time when the world would be stopped altogether. Every time we used the force of the tides and wind, we were assisting to stop the rotation of the earth.

The CHAIRMAN remarked that the retardation was very slow, as we only lost one second in a thousand years. He then formally put the vote of thanks, which was carried unanimously, and the proceedings terminated.

Miscellaneous.

AGRICULTURE IN BOLOGNA.

The principal agricultural products of the province of Bologna are—hemp of an excellent quality, giving an annual yield of about 120,000 quintals; wheat, generally the bearded variety, of which there is not always sufficient for local consumption, about 900,000 quintals; and rice, about 225,000 quintals in the husk, which is afterwards cleaned for consumption, about half the yield being being exported. Enough fodder (hay, straw, &c.) is produced, not only to feed the cattle of the province, but to allow of occasional exportation. The figures of an average yield are—hay, 600,000 quintals; straw for fodder, 1,700,000 quintals; straw and litter made from marsh plants, 2,650,000 quintals. There is also a very large quantity of clover, medick, and sainfoin seeds produced. The vines of the province yield above 400,000 hectolitres of must, and great progress has been made of late years in the cultivation of the vine; vineyards, laid out according to the French system, are rapidly becoming more common, especially on the hills; greater care is also taken in separating the different qualities of grapes. Among secondary products, may be noticed Indian corn, spring grain, vegetables, garden produce of all kinds, tomatoes, in which there is annually a very large trade carried on, fruit, chestnuts, and other articles of local consumption. Consul Colnaghi, in his report on the agriculture and industries of Bologna, states that the métayer system of tenancy prevails in the greater part of the province, though a method of cultivation under the direct management of the owner, termed "in economia," or "in boaria," is extending in the plain. The "boaria" is either pure or mixed. In the first case, which is very rare, the "boaro" is paid by wages only, in the second he has a share in the product of certain cultures as well as wages. In the plain, the lease of large properties, comprising several farms, to capitalists is frequent; but leases to small farmers, both in the plain and hill districts, are rare. The ordinary term of a lease is for nine years, but in the case of large estates, a twelve years' lease is granted; and when large works have to be undertaken, even longer. At the expiration of the lease, the outgoing tenant has the option of renewal, but more from custom than absolute right. Notice to quit is given to tenants on the 31st May, the tenancy terminating on the 1st November. The outgoing métayer has the right of harvesting the wheat sown in October on the following year, so that the farm is not finally quit of him until the end of the subsequent June, or middle of July; this custom, however, is fraught with considerable inconvenience, and it is in contemplation to substitute for it an estimate of the value of the crop, as is now done in the case of medick, for which compensation is granted. Although the general outlines of the métayer system are the same throughout Italy, namely, an equal division of the products of the soil between landlord and métayer, they differ in various particulars of more or less importance, so that the position of the farmer is better in some provinces than in others. In the province of Bologna the field cultures are equally divided between the two parties to the contract; this equal division, however, does not apply in all cases to the meadow land, to the produce of the mulberry trees or to the vines, which are subject to special contracts. The "onoranze," as they were termed, consisting of poultry, pork, eggs, vegetables, &c., with which the métayer was bound to furnish the landlord, appear now to be commuted, in the plain, for a money payment at the rate of 15 lire per hectare. The métayer pays a small rent for his house, and also 2 lire 50 c. per quintal on his share of the fibre for steeping the hemp. The landlord supplies half the manure that has to be purchased for the use of the farm, and from a quarter to half the marsh litter ("strame vallivo"), and generally contributes one-third towards the cost of the labour required for the preparation of the land for hemp; he pays also the whole of the land tax, and half the tax on cattle. The métayer pays the income and hearth taxes, and the remaining half of the cattle tax. The cattle are held in various ways, and are either shared between landlord and métayer, or are the entire property of the landlord; but, in this case, the métayer pays half the interest of the money expended on their purchase, or they may belong altogether to the peasant, or to some third person, under what is termed the contract "di giovatico." The relations between landlord and métayer are generally good, less so between landlord and "boaro." The condition of the métayer is considered to be superior to that of the "boaro," inasmuch as the descent to the condition of a day labourer is easier for the latter than the former. There is also a very material difference between the conditions of the métayer and the "braccianti," or day labourer, the condition of the latter being very precarious. A day labourer cannot earn more than 300 lire per annum, as at the best he only works for 220 or 230 days in the year. In the summer he earns 1 lire 60 c. to 2 lire per diem; during wheat harvest,

rather more. When working for a métayer he also receives food, which, during the harvest, is of a better description than usual, but this does not last longer than a fortnight. When preparing the land for hemp, the labourer, in addition to his wages, receives a slight refection, termed "la ben cotta." For certain field works also wine is given by the farmer; but "vino da opere," or the workmen's wine, is of a very poor and coarse description. Under the "boaria" system the labourer receives no food, but a higher rate of wages. The wives and daughters of the labourers attend to field work, and their wages are about half those of men. The food of the "braccianti" consists principally of wheat, bread, and polenta, the latter being made of Indian corn. The size of the farms in the best part of the plain is from fifteen to twenty hectares for large cultures. There are also farms of five or six hectares on the hills and near the towns, where market produce is chiefly grown, with still smaller properties in the mountains. The soil of the province in the plain is of considerable depth, and is chiefly composed of a tenacious calcareous clay, the clay in some cases being in the proportion of 70 per cent. to the other constituents. The hills are composed of two types of soil, the one showing a prevalence of yellow sand, the other of calcareous clay; there exists also a third class of lands ("calanghi") on the higher hills, formed of a bluish argillaceous schist, easily disintegrated and liable to frequent landslips. These latter are almost unproductive. There are two methods of laying out the fields, "à cavaletto," and "à rivale;" the first for the heaviest, the second for the lighter soils. In the system "à cavaletto," the trees which form the boundary to each field are planted on a narrow strip of land ("cavaletto") raised between the side ditches of each division; in that, "à rivale," the trees are planted on one side of the field itself. The trees planted in the fields to which the vines are, in Italian parlance, married, are generally elm or maple. Near the towns, cherry or other fruit trees are employed. Mulberry trees are usually planted in the vicinity of the farm houses. The fields, which are termed "fetta" or "pezzo," generally contain 3,000 square mètres—they are 75 mètres long, and 40 wide—and have ditches on the two sides, with slight depressions at the ends. The system of rotation is biennial on the lighter lands devoted to hemp; first year hemp, second year wheat. On heavier soils it is triennial — first year, hemp; second year, Indian corn; third year, wheat; first year, hemp; second year, wheat with clover, which forms the crop for the third year. On every good farm, generally a fifth part is reserved for artificial meadow, and this, if medick is sown, lasts about six years, after which period it is changed, the meadow being transferred to the hemp ground, the hemp to the wheat, and so on. The heavy lands of the plain require a large amount of animal power, and sometimes as many as five or six yoke of oxen are used. Cows are only employed as auxiliaries; the wheelers are always oxen. The great depth of the soil renders the drainage difficult, and is the probable cause of the system of "estivatura" which is adopted on the plain lands. The "estivatura" is a method of raising the level of each field, and forming a gradual slope from a central ridge to the sides, by which the drainage is effected into the side ditches without the necessity for other works. The preparation of the soil for the hemp, an operation which is termed "ravagliatura," and is said to be peculiar to Bolognese agriculture, is a double work, performed by plough and spade labour. The furrow is first opened out with the plough in the usual way, to the depth of 30 centimetres, after which a further depth of 15 to 20 centimetres is dug out and broken up by hand labour. From 20 to 24 labourers are employed on this work per hectare. Two different kinds of ploughs, called "ravagliatori," have been invented for this operation, so as to be able to dispense with hand-labour, but they are not generally used. The hemp is steeped in tanks constructed for the purpose, one of which is generally attached to each farm, though in some cases one steeping place is used in common by several proprietors. The steeping lasts about eight days, after which the hemp is taken out and dried. It is then brought to the farm and passed through a machine to break the stalks, after which it is properly cleaned (scutched) by hand. It is next exposed for a few hours to the dew, and then placed in heaps and sold to the merchant, who generally sends his own workmen ("ammarratori") to make it up into bales of about 200 kilos each.

The agricultural implements in use on the farms are generally of good quality and of improved models, and there are a good many threshing machines in use on the plain, nearly all of English make. The presence of the trees at the side of the fields, with the pendent vines, the number of drainage canals, and the subdivision of the land in the plain, prevent, however, the general introduction of steam-ploughing.

GOLD PRODUCTION IN THE UNITED STATES.

Mr. Burchard, the Director of the United States Mint, says that the auriferous area of the State of Georgia covers something more than one-third of the northern portion of the State, and stretches from South Carolina on the east to Alabama on the west; it is geologically the area of North and South Carolina. Only a few points, comparatively, of this area have, however, produced gold on a working scale. The only parts now extensively worked are in Lumpkin, Dawson, and White counties, the first named being the most prolific. Schists everywhere make up the country—chloritic, micaceous, talcose, and sometimes, though rarely, hornblendic. They are usually decomposed to a great depth, and easily broken up, and when not decomposed, they are soft enough to yield to the pick. The country is extremely

broken and mountainous; the valleys are usually deep and traversed by bold streams carrying an abundance of water; the hills are so connected by ridges as to allow an easy conveyance of water by cheaply made ditches. The gold appears to occur in seams of quartz, which traverse the strata in great numbers' usually parallel to the strata, and varying in thickness from a quarter of an inch to six inches. There are zones of strata which are particularly abundant in these seams, with a width varying from ten to four hundred feet. The mining is carried on in these zones, as outside of them the seams are so few as to make the ore of too low grade to be of economic importance. These belts run across the country with the strata in a general north-east and south-west direction, that is, at points long distances apart, and in the general alignment of the strata, bodies of ore are found of the same general character. Gold was discovered in Georgia between 1828 and 1831, about the same time as in the Carolinas. For twenty years, the ravines, and particularly the streams, where nature had concentrated the gold in the course of ages, gave opportunities for the most profitable work. The exhaustion of this readily-worked ground led to attempts to work the veins. The richer parts of them allowed profitable work a little longer, but mining in Georgia was, for many years, relatively unprosperous. During the last five years, gold-mining has been placed on a firmer basis, as the possession of bodies of ore, whose locality, extent, and richness were easily ascertained, together with a sure supply of water, removed the subject from the region of probability, and made it more of a certainty. The ore is of very low grade, and the average value is from 5s. to 6s. per ton. Two of the most important mines are the "Pigeon Roost," and the "Findley," and at both the production has been considerable, the former in particular, as it is provided with better appliances to secure economy and efficiency. It is operated by a turbine, so that the cost of motive power is very small. The yield, in 1879, was 35,000 dollars, and it is expected that the returns of 1880, which have not yet been received, will show a considerable increase over this amount. The "Findley" mine is well provided with ample mining ground to supply the large mills, of which it has two, provided with stamps in all. Its production is but little behind that of "Pigeon Roost." Mr. Burchard states that the tendency, in Georgia, has been to form too small companies, and is of opinion that the necessity exists for the formation of a large establishment, provided with the requisite facilities for the treatment of large bodies of ore. Mining ground is held at moderate rates, and the necessary machinery can be obtained at very moderate cost; in a recent purchase, the entire cost of mine ditches, waterworks, buildings, and expenses of opening were under 1,700 dollars. It is estimated that the value of the total production in England amounted, in 1880, to 121,880 dollars; and this estimate, according to Mr. Burchard, is rather below than above the mark.

*CORK.**

Cork is yielded by the cork oak, *Quercus liber*, which chiefly flourishes on the shores of the Mediterranean. There are, in Spain and Algeria, large forests of this tree, which is also cultivated in the departments of Lot-et-Garonne and Var, in the south of France, and in Corsica.

The cork oak arrives at its full growth in about 100 years, when, in hot climates, it attains a height of sixty or seventy feet, with a diameter of six to eight feet. The bark consists of two distinct portions, the inner formed of a fibrous tissue, and the outer, tuberous, and of a porous and elastic consistency, which constitutes the cork proper. The first cork naturally produced by the tree is called the male, and has scarcely any value; but if this be removed, a second layer is formed, finer, more elastic, and less irregular, which is known as the female cork; and this it is which is generally used.

The stripping of the cork takes place in summer, when the circulation of the sap facilitates the separation of the outer from the inner layer of bark. The removal of the first growth is affected when the tree is twenty to twenty-five years old. Several annular incisions, and one vertical incision, are made with a hatchet, care being taken to cut the cork only, without touching the inner bark; the layer of cork is then easily detached. A young oak yields about 10 lbs. of cork at the first stripping, while it is capable, ultimately, of yielding over 300 lbs. The first cork has a thick and hard exterior, which diminishes with each successive growth. Formerly, after the first stripping, the tree was left to itself, without any protection. Being very tender, it was liable to be killed by exposure to variations of temperature, while numerous insects, attacking the tender surface of the tree, reduced the value of the the future cork. Besides, a thick and irregular crust formed, which it was necessary to remove, thus causing a loss of 30 per cent. of cork.

A better plan is to employ the method of M. Capgrand-Mothes, which consists in covering the tree during several months after stripping, with the cork which has been removed. A few vertical incisions are made in the inner bark, to prevent irregular furrows being formed. The pieces of bark are then restored, being fastened by iron wire; and the joints are made good underneath with strips of cellulose cardboard. After three months, in the autumn, the pieces of bark have become quite dry, and are taken off. The effect of this practice is to induce the formation of a protecting layer, tuberous, homogeneous, and elastic, under which the growth of the cork goes on without danger of injury.

The detached pieces of cork, flattened by being piled up with the outside uppermost, are freed from their external surface by boiling and paring. The

* Abstracted from a paper by M. Henri Mamy, Ingénieur des Arts et Manufactures, in the columns of the *Moniteur Industriel*.

boiling of the cork, which lasts about half-an-hour, is effected in large cubical boilers fired with refuse cork, and closed by a cover which presses upon the pieces. The paring is done by hand, or by means of horizontal rollers provided with iron blades; but this last-named operation may be dispensed with when the practice of covering the tree with the detached pieces of bark is adopted.

The principal use of the outer bark is to make bottle corks. They are more frequently cut by hand, though sometimes by a machine, a horizontal knife giving a rotary motion to the piece of cork, and thus cutting it into a cylindrical form. Cork is also used for making life buoys, swimming belts, floats, non-conducting linings, &c. It is moreover used advantageously in the form of powder, for packing fragile objects, as a substitute for lycopodium powder, and for the manufacture of linoleum and cork-leather. Cork is, however, on account of its elasticity, reduced to powder with great difficulty. To effect this, mills with grinders in the shape of rasps, mill-stones revolving in a pan, and artificial stones revolving at great speed, are employed.

Linoleum consists of cork-powder consolidated with dried linseed oil. The mixture, in the proportion of about 3 parts of oil to 1 of cork-powder, is passed under heavy rollers, and then stuck on to cloth by means of drying oil. It is allowed to dry for about three months, when the product is ready to receive various designs, and may be readily washed. Linoleum is adulterated by adding sawdust to the cork-powder. Cork-leather, which is waterproof and very elastic, is cork-powder consolidated with indiarubber.

Cork refuse is used for making partitions that do not conduct heat or sound; it also yields a light and porous charcoal. M. Combe d'Alma has proposed to distil them, so as to obtain a very rich gas, free from sulphuretted hydrogen. Old bottle corks are sometimes collected, boiled and washed in acidulated water for again serving to cork bottles.

Notes on Books.

Ottoman Poems, translated into English Verse in the Original Forms, with Introduction, Biographical Notices, and Notes, by E. J. W. Gibb, M.R.A.S. London: Trübner and Co. 1882.

Mr. Gibb has translated a selection of poems by some of the chief Ottoman poets, and has imitated the original form in English. To these poems he has added an account of the various verse forms and metres in use in Persian and Ottoman poetry, as well as biographical notices of the poets themselves. There is a considerable variety of forms in the rhyming system adopted by the poets, and different forms are used according to the subject to be treated of. The editor draws attention to the fact that before 1879, when Mr. Redhouse published his essay on "The History, System, and Varieties of Turkish Poetry," no work had appeared on the subject. The present book is intended as a more extensive review of the same subject, and contains a considerable number of pieces that have not before appeared in any European language.

Dictionnaire Technologique dans les langues Francaise, Anglaise, et Allemande, redigé par Alexandre Tolhausen, revu par Louis Tolhausen; troisième édition. Leipzig: Bernhard Tauchnitz. 1883. Grand Supplément, 1883.

The first edition of this book appeared ten years ago, in 1873, and it has now grown into a much thicker volume by the addition of the supplement, which contains the many technological words and expressions that have come into use during the period.

On the Conservation of Solar Energy: a Collection of Papers and Discussions. By C. William Siemens, F.R.S., D.C.L. London: Macmillan and Co. 1883.

This volume has grown out of the discussion which followed the publication of Sir William Siemens's Royal Society paper, on "Solar Energy," early last year. The theory originated in that paper attracted a large amount of attention, and its author set himself to reply to the various objections which were made to it. The fundamental conditions of the hypothesis are—1, that gases are present in space; 2, that compound gases, when extremely attenuated, can be dissociated by radiant solar energy; 3, that solar rotation draws in dissociated gases at the sun's polar surfaces, and ejects them equatorially after combustion into space. Most of the criticisms have appeared in *Nature*, and these Sir William Siemens answers one by one, the letters and the replies being printed in sequence. M. Faye's and M. Hirn's criticisms were originally printed in the *Comptes Rendus* of the French Academy. The appendix to this volume contains papers on the "Electric Furnace," by Sir Wm. Siemens and A. K. Huntington; on "Sunlight and Skylight at High Latitudes," by Captain Abney; and on "Dissociation of Attenuated Compound Gases," by Professor Liveing.

General Notes.

Incombustible Paint.—MM. Vildé et Schambeck propose the following mixture for rendering wood-work incombustible:—Pulverised glass, 20; pulverised porcelain, 20; pulverised stone, 20; calcined lime, 10; silicate of soda, 30: total, 100. The

solid elements must be reduced to as fine a state as possible and sifted, and then mixed intimately with the soluble glass, thus forming a glutinous mass which may be employed, as it is, for painting, or may be mixed with various colours. The addition of the lime gives a certain unctuosity to the mass for painting, while the combining of this lime with a portion of the silicic acid of the soluble glass promotes the ultimate mixture of the other substances. Although the mixture given above is recommended as being the best, the proportion of the various elements may be changed according to circumstances, except that of the soluble glass, which must remain constant. Some of the substances may also be replaced by others, but it is advisable to retain the lime. Instead of silicate of soda, the soluble glass of potash may be employed, but the former is cheaper. The paint is laid on with a brush in the ordinary manner, and as evenly as possible on the surface to be protected. The first coat sets immediately, and the second may be applied from six to twelve hours afterwards, two coats being sufficient. This composition may also be employed with advantage for protecting iron bridges, sleepers, &c., from oxidation.

London Improvements.—From a return made to the Metropolitan Board of Works, it appears that the total expenditure of works executed by the Vestries and District Boards of the metropolis, from 1856 to 1881, amounts to £11,513,565 10s. 5d. This sum is made up of the following items:—Cost of new sewers constructed, £2,310,890 7s. 2d.; expenditure on other sanitary works, £2,162,769 19s. 9d.; cost of paving works, £5,535,073 7s. 5d.; expenditure on other street improvements, £1,504,831 16s. 1d. The length of new sewers constructed is put at 919 miles 309 yards; the length of streets and roadways under control of Vestries or District Boards, was 925½ miles in 1856; it was 1,607⅝ miles in 1881. The number of street lamps added during the period 1856–1881, was 26,444. These figures do not include works in the City. The Metropolitan Board itself has expended from 1855 to 1882 about 5½ milions sterling upon the works for the interception of the sewage from the Thames, and upon the reconstruction of the main sewers, over ten millions; nearly a million and a-half on the freeing of the bridges; nearly a million and a-half on artisan and labourers' dwellings; over £450,000 for parks, gardens, and open spaces; nearly a quarter of a million for fire-stations, appliances, &c., in addition to the annual expenditure of £100,000 on the fire brigade. The total amount expended by the Board during the period considerably exceeded twenty millions.

Calcutta International Exhibition.—Communications recently received from the Vice-President of the Executive Committee at Calcutta (the Hon. Col. S. T. Trevor, R.E., Joint Secretary, Government of Bengal, Public Works Department) are to the effect that all the necessary annexes in course of erection, adjacent to the India Museum, will be completed by July or August. A large space on the Maidan, facing the museum, has been enclosed, and will be devoted specially to machinery in motion, agricultural implements, &c. Gas and water will be available throughout the building. The arrangements in regard to lighting are now under consideration; it is proposed that, for this purpose, the electric light should be employed. A deep reservoir, covering an area of nearly 90,000 square feet, will serve for exhibiting specimens of native boats, and for displaying diving apparatus and life-saving apparatus, including boat and steam-launch machinery. The exhibition of Oriental jewellery is expected to surpass any previous display of the kind. In addition to the splendid collection lately shown at the Nypore Exhibition, there will be contributions from the Indian princes and nobles. The regalia of each potentate is to be shown separately. The Public Works Department of the Government of India has communicated with the governments of the several presidencies and provinces, requesting them to obtain from the railway authorities under their control special rates for the carriage of goods intended for the Exhibition. In considering the allotments of space, priority will be given in accordance with the dates of the applications.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

May 9.—"English and Foreign Silver Work; with Some Remarks on Hall-markings." By Wilfred Cripps, F.S.A. Sir Philip Cunliffe-Owen, K.C.M.G., C.B., C.I.E., will preside.

May 23.—"Technical Education in connection with Intermediate Schools." By Philip Magnus, B.Sc., B.A.

May 30.—"The Relative Claims of Etching and Engraving to Rank as Fine Arts." By F. Seymour Haden, F.R.S. Sir Rutherford Alcock, K.C.B., will preside.

Foreign and Colonial Section.

Tuesday evenings at Eight o'clock:—

May 29.—"Queensland: its Progress and Resources." By Arthur J. Stainsby.

Applied Chemistry and Physics Section.

Thursday evenings at Eight o'clock:—

May 24.—"The Development of Electric Lighting." By J. E. H. Gordon, B.A.

Indian Section.

Friday evenings at Eight o'clock:—

May 25.—"Some Notes on the Domestic Archi-

tecture of India." By C. PURDON CLARKE. Sir PHILIP CUNLIFFE-OWEN, K.C.M.G., C.B., C.I.E., will preside.

CANTOR LECTURES.

Monday evenings at Eight o'clock:—

Fifth Course, on "The Transmission of Energy." By OSBORNE REYNOLDS, M.A., F.R.S., Professor of Engineering at Owens College, Manchester.

LECTURE III.—MAY 7.

The transmission of energy through pipes and conductors; summary of economic considerations relating to the transmission of energy.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Osborne Reynolds, "The Transmission of Energy." (Lecture III.)

Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Mr. W. Brown, "The Measures before Parliament affecting Agriculture."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Society of Engineers, 6, Westminster-chambers, S.W., 7½ p.m. Mr. George Bower, "The Bower-Barff Process of Preserving and Ornamenting Iron and Steel Surfaces."

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Wilfred Powell, "Visits to the Eastern and North-Eastern Coasts of New Guinea."

British Architects, 9, Conduit-street, W., 8 p.m. Annual Meeting.

Medical, 11, Chandos-street, W., 8½ p.m. Annual Oration.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Paper by Professor J. L. Porter.

Society of Chemical Industry (London Branch), Burlington-house, W., 8 p.m. Mr. C. T. Kingzett, "Secondary Batteries."

TUESDAY, MAY 8...National Veterinary Association (at the HOUSE OF THE SOCIETY OF ARTS), 10 a.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor McKendrick, "Physiological Discovery." (Lecture VI.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. James N. Paxman, "Diamond Fields and Mines of Kimberley, South Africa."

Photographic, 5a, Pall-mall East, S.W., 8 p.m.

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. Frederick Bonney, "Some Customs of the Aborigines of the River Darling, New South Wales." 2. Lieut.-Col. H. H. Godwin-Austen, "The Discovery of some Worked Flints Cores, and Flakes, from Blackheath, near Chilworth and Bramley, Surrey." 3. Admiral F. S. Tremlett, "Notes on Stone Circles in Brittany." 4. Mr. C. Staniland Wake, "The Nature and Origin of Group Marriage."

Royal Colonial, the Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Mr. John Ferguson, "Ceylon."

WEDNESDAY, MAY 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Wilfred Cripps, "English and Foreign Silver Work; with some Remarks on Hall-Markings."

Geological, Burlington-house, W., 8 p.m. 1. Prof. C. Callaway, "The Age of the newer Gneissic Rocks of the Northern Highlands;" with Notes on the Lithology by Prof. T. G. Bonney. 2. Prof. C. J. Woodward, "A Group of Minerals from Lilleshall, Salop." 3. Mr. Arthur Wm. Waters, "Fossil Chilostomatous Bryozoa from Muddy Creek, Victoria."

Microscopical, King's College, W.C., 8 p.m.

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

THURSDAY, MAY 10...Royal, Burlington-house, W., 4½ p.m. 1. Prof. Hughes, "Theory of Magnetism, based upon New Experimental Researches." 2. Capt. Tizard, R.N., "Remarks on the Soundings and Temperatures obtained in the Faeroe Channel during the Summer of 1882." 3. Dr. Wooldridge, "Preliminary Note on the Innervation of the Mammalian Heart." 4. Dr. Ferrier, "Note on the Motor Roots of the Brachial Plexus, and on the Dilator Nerve of the Iris."

Antiquaries, Burlington-house, W., 8½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. G. A. Storey, "On Art."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "Count Rumford." (Lecture II.)

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. 1. Mr. J. H. A. MacDonald, "The Electric Holophote Course Indicator, for the Prevention of Collision at Sea." 2. Professors W. E. Ayrton and John Perry, "Electro-Motors and their Government."

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Professor Genese, "Relations between the Common Points and Common Tangents of Two Conics." 2. Mr. W. R. W. Roberts, "The Motion of a Particle on the Surface of an Ellipsoid." 3. Mr. Tucker, "Two Concentric Circles."

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Annual Meeting.

FRIDAY, MAY 11 ... Royal United Service Institution, Whitehall-yard, 3 p.m. Captain G. H. U. Noel, "The Masting of Ships of War."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m.. Prof. Huxley, "Oysters and the Oyster Question."

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, MAY 12...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Capt. Abney, "Measurement of Radiant Energy." 2. Mr. C. J. Woodward, "An Experiment Illustrating Motion, produced by diffusion." 3. Prof. Clifton, "A Complete Determination of a Double Convex Lens by Measurements on the Optical Bench."

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 8 p.m. Professor Geikie, "Geographical Evolution." (Lecture VI.)

Journal of the Society of Arts.

No. 1,590. Vol. XXXII.

FRIDAY, MAY 11, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's Annual Conversazione will be held this year in the Buildings of the International Fisheries Exhibition. His Royal Highness the Prince of Wales, President of the Society, has intimated his intention to be present.

The precise date will be hereafter announced, and cards of invitation will be issued to the members of the Society in due course. Each member will, as usual, receive a card for himself and a lady.

CANTOR LECTURES.

The third and concluding lecture of the course, on "The Transmission of Energy," was delivered by Professor Osborne Reynolds, F.R.S., on Monday evening, the 7th inst. The lecture was chiefly devoted to the consideration of the conditions under which 1,000 horse-power can be transmitted through various mediums, and concluded with a summary of the economic considerations relating to the transmission of energy.

The Chairman (Mr. W. H. Preece, F.R.S.) moved a vote of thanks to Professor Reynolds for his valuable course of lectures, which was carried unanimously.

The lectures will be printed during the autumn recess.

PREVENTION OF FIRES.

The Committee appointed by the Council to consider the question of fires in theatres has reported, and their report will be published in an early number of the *Journal*.

A public meeting will be summoned by the Council to consider this report. The meeting will be held about the end of the present month.

Further particulars will appear in future numbers of the *Journal*.

PRACTICAL EXAMINATION IN VOCAL OR INSTRUMENTAL MUSIC.

The next Examination in London will be held at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing on the 11th June, 1883.

Honours.

The Examination in Honours will consist of three sections, viz., a paper to be worked, an examination similar in form to the practical examination for a First and Second-class, and a *viva-voce* examination.

First and Second-class.

Vocal.

Candidates for a First or Second-class Certificate in Vocal Music will be required—

[1.] To sing a solo, or to take part with another candidate in a duet, already studied.

[2.] A key-note being sounded and named by the Examiner, the candidate to name sounds or intervals, or successions of sounds or intervals, played or sung by the Examiner.

[3.] To sing or sol-fa at sight passages selected generally from classical music.

Instrumental.

Candidates for a First or Second-class Certificate in Instrumental Music will be required—

[1.] To play a short piece, or a portion of a larger work, already studied.

[2.] A key-note being sounded and named by the Examiner, the candidate to name sounds or intervals, played by the Examiner.

[3.] To play a piece or portion of a piece at sight.

Full particulars can be obtained on application to the Secretary.

Proceedings of the Society.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 9th, 1883; Sir Philip Cunliffe-Owen, K.C.M.G., C.B., C.I.E., in the chair.

The following candidates were proposed for election as members of the Society:—

Harwood, John, J.P., Woodsleigh, near Bolton.
Ross, O. C. Dalhousie, Little Bookham, Leatherhead.

The following candidates were balloted for and duly elected members of the Society:—

Kinsey, William Barns, Michwood Church-lane, Merton, Surrey, and 33, The Exchange, Southwark-street, S.E.
Martin, John May, Castle-chambers, and Bradninch-house, Exeter.
Scott, Mrs., 3, Harrington-mansions, Queen's-gate, South Kensington, S.W.
Smith, Reuben, Moulton Grammar-school, Spalding, Lincolnshire.
Sudeley, Lord, 7, Buckingham-palace-gate, S.W.
Whitwill, Mark, J.P., Redland-house, Bristol.

The paper read was—

ENGLISH AND FOREIGN SILVER WORK: WITH REMARKS UPON THE PLATE DUTIES, COMPULSORY HALL-MARKING, AND THE CONSTITUTION OF THE GOLDSMITHS' COMPANY.

By Wilfred Cripps, F.S.A.

I have been asked to read a paper to the Society upon a subject to which I have paid a great deal of attention for some years; and I must begin by saying that it was only with much hesitation that I ventured to accept the invitation, feeling that I might not be able to make my subject as interesting, as it seems to myself, to a critical audience, accustomed to discuss, from week to week, geographical, scientific, and commercial questions of greater national importance than any that an art-industry—even if a considerable one—can lay claim to.

I propose to treat the subject of the goldsmith's art from an historical point of view, and, considering its present position amongst the industrial arts, rather than dealing with its technical processes, to endeavour to show how a freer access than has hitherto been possible to the best examples of the work of past days, may be made to carry forward the objects of a Society established "for the encouragement of Arts, Manufactures, and Commerce."

It is some advantage to me that the subject has not engaged the attention of the Society for years past—not, I believe, since the late Mr. Burges's Cantor Lectures in 1864; for a great deal more is now known of gold and silver work, its history, dates, and styles, than was known then.

This is due to various causes, partly to the interest excited in the art of dating old English plate, first by the antiquarian discoveries of my friend Mr. Octavius Morgan; and partly to the attention that the art revival of the past quarter of the century has drawn to questions relating to the industrial arts.

It may be as well to indicate the ground covered by Mr. Burges's lectures, without attempting to go over it again. He rather dwelt upon the antiquities and technicalities of craftsmanship, from the days of the Roman Mentor and his wealthy patron, Lucillus Crassus, down to mediæval days; reviewing, shortly, the processes by which the precious metals were enriched with ornament, such as engraving, embossing, enamelling, chasing, punching, filigree work, and the like; and enumerating a few of the more important classes of objects upon which the mediæval smith worked for church, noble, or wealthy guild. Chief amongst these were chalices, and the curious "nefs," which formed so striking a feature in the table arrangements of our ancestors. He then turned the attention of the Society to jewellery, noting the interesting fact that Signor Castellani was said to have discovered men, in some remote villages of Tuscany, still working at the ancient art of frosting articles of jewellery in gold, by soldering particles of the precious metal upon their surfaces—an art long supposed to be wholly lost; and he finished his sketch by a notice of the coinage of different countries, from Greek times and the celebrated Syracusan series, down to our own Georgian money, which he compared with that of the French Republic, somewhat to the disparagement of English art at that period.

It will be seen from this short summary of Mr. Burges's lecture, that amongst the industrial arts, that of the goldsmith is by no means an insignificant or unimportant one; and it is perhaps open to question why it does not seem to have shared to the full the tide of advance, from an art point of view, that has come to many others of the industries that minister to the comfort and luxury of modern life.

It is trite, at this time of day, to remark that, in the earlier days of the present century, all these arts were neglected alike; that people were satisfied to buy what the tradesmen offered; and contented, if objects of taste or beauty of design were desired, to go abroad to more art-loving countries, and fetch them home for themselves.

All this is now altered, chiefly owing to the enlightened mind and foresight of H.R.H. the

late Prince Consort, and the development of his work and wishes into such powerful agencies as the Society of Arts, and State Departments like that which our distinguished friend in the chair now so ably directs.

The improved position of the decorative art-industries in England is so obvious and so fully admitted, that it hardly needs to insist on the prosperity that has been more than ever marked since the last Paris Exhibition. Suffice it to say, that Mons. Lockroy, in a Report of the year 1881, to the French Chamber, on the estimates for the fine arts, says plainly, "England has become our equal in furniture and ceramics." I quote this, because it leads up very conveniently to the way in which I propose, with your permission, to treat our subject this evening.

M. Lockroy does not mention English *orfèvrerie* as to be feared; and this coincides with a somewhat general belief that, in gold and silver work, England does not show so decided an advance as in the lines which M. Lockroy especially mentioned, to which he might have added several others.

Under the general term of silver ware must be included, for our present purpose, and in deference to the wants and requirements of the day, electro-plate; for the art of the matter, so far as that goes, is the same whether it is presented to the eye of the purchaser in real silver, or in some cheaper material, taking the same forms and appearance.

We need not, perhaps, take it for granted that, as regards these crafts together, we do not observe in our shop windows any of the same advance that is so noticeable in glass, pottery, tapestries of all kinds, furniture, and the like; but whatever want of progress we choose to admit, we can comfort ourselves with the feeling that the art is backward not alone in our own country. My own opportunities of observing such things convince me that neither the French nor the Germans produce any better nor any more artistic silver and electro-ware than ourselves; and if now and then some American fashion of decorating plate seems to carry all before it for a few months or a year, after a short time you can no more find the class of work which was for a season so popular, than you can get a copy of the *Daily News* or the *Standard* of day before yesterday.

It must further be laid down against ourselves, if we do admit want of taste and lack of good art in the articles displayed in the windows of our silversmiths, that it is really, and in the end, attributable to want of demand on the part of the public for something better.

Trade depression or stagnation is a good excuse, a good herring to trail across the scent, but it has very little, if anything to do with the matter. It is not that shop windows are too empty, but too full of bad art, so full, indeed, that they contradict of themselves the very allegation of any serious depression.

It must be borne in mind that it is utterly fallacious to take the weight of silver work paying duty as any measure of the amount of silver worked up annually, which is enormous. Such returns take no account of the great amount of metal used in the electro-plate trade; and, however much some may deprecate it, much of the money that was formerly spent upon silver plate is, and will be for the future, spent upon electro wares.

Of these two classes of goods taken together, it is not the fact that the public are not buying all they want, and at prices that are remunerative to the trades; but it is the fact that, owing to want of educated taste, and for the want of the stimulus that access to, and study of, the best models of other times would supply, the general public have been contented with what they found ready made; and the manufacturer has been well pleased to supply his customers with things of which he had stock patterns, so long as the public were contented with them.

Neither party is exactly to blame for this state of things. It is difficult to believe how little was known about old English silver-work, as a matter of art-history, twenty-five years ago. Perhaps a dozen pieces, including the regalia at the Tower, were all that were popularly known, and the supposed histories of many of these specimens has turned out to be entirely imaginary.

It is just here that Government, and Government alone, can assist an art-industry in the most useful way. It is all very well to cry out for direct help, for protection, for bounties, for impossible or inopportune remission of taxation, and the like. In the present case Government can do what is much better. It can make it the business of its art-departments not only to educate the trade and the workman, and encourage the supply to the public of good art work, through the machinery of its schools of design and technical schools, but to educate the eye of the public itself, and to create a dissatisfaction with, and a distaste for, anything that is not good.

Now, what has Her Majesty's Government effected for the goldsmiths' art at present?

It has, in the first place, set itself to show that the art of the goldsmith in England is an art with a history; that it has had periods of excellence which have given its productions from time to time the rank of works of art, and to their authors that of artists. It has used its influence—an influence no private person or body can wield—to find out in what treasuries and depositories, royal, collegiate, or corporate, ecclesiastical or secular, the most precious and typical specimens of the art of all ages in English history are preserved And it has obtained permission to make copies in *fac-simile* of them, not only for the use of the art-student in the metropolis, but for the purpose of sending them throughout the length and breadth of the country, for the use of his provincial brother studying in the local schools of art which have been everywhere established, and for furnishing local exhibitions on a circulating loan system, of which the success promises I think, speaking as one of the outside public, to be most remarkable.

May I be pardoned for mentioning that two former pupils of the small country school of art in which I myself am most nearly interested — pupils whose humble parentage would, only a few years ago, have put any art-education entirely out of their reach—have works on the walls of the exhibition of the Royal Academy for the present year.

I am able to-night to submit to the examination of the Society a series of these reproductions, which illustrates the history of silver-working in a way that, till lately, would have been impossible, except on one of those rare occasions like the Loan Exhibition, at South Kensington, in 1862, when a sufficient number of precious and treasured objects could be drawn from their hiding places and exposed to public view, for a few weeks or months at the most. And I hope it will not be tedious if I say a few words about some of them (for they are very little known), pointing out the reasons for their selection and their place in the history of the art. I may mention that almost every collection in the kingdom was freely placed for these purposes at the disposal of the Science and Art Department, from Her Majesty's own treasures, those of the colleges of both our great Universities, and the great guilds in the City of London, downwards; and the result is that every age and every style and varying fashion of English silver working, for four centuries, is represented by its best remaining specimens. I feel sure the Society will hope with me that this liberality may be productive, in due course of time, of the happiest result to the art and craft in England, and I will add abroad, for the work undertaken by the British Government, I think Sir Philip Cunliffe-Owen feels, is to some extent an international one.

Let me first draw your attention to this English series—a history of English plate-working in epitome. We must not expect to find such treasures of ancient art in England as the Scythian ornaments from St. Petersburg, brought there from the Cimmerian Bosphorus, the Gothic treasures discovered in Wallachia, or the Visigothic votive crowns found near Toledo. The earliest English work known consists of personal ornaments of the Saxon period, and Celtic gold work in torques, armlets, gorgets, and the like, found in Ireland. We must pass over such relics as the Ardagh Cup and the St. Patrick's bell-cover (an electrotype copy of which may be consulted in the South Kensington Museum), and come to the 14th century at once. Not but that, for two hundred years before that, the craft had flourished in England; the Goldsmiths' Company had been fined for being "adulterine," or established without royal licence, as early as the year 1180, and whole generations of craftsmen, especially famous for their *champlévé* enamelling, had lived and died. The Goldsmiths' Company of London was regularly incorporated in 1327, and its mark of a leopard's head is even then described as "anciently ordained."

The earliest known piece of importance is of about this period. It is the Mayor of Lynn's cup, traditionally said to have been given to the borough of King's Lynn by King John. Like other traditions, this is without foundation in fact; for the costumes of the enamelled figures with which the ground of the bowl is covered are of the middle of the 14th century. It is, however, of excellent Gothic taste, and is a worthy introduction to English craft-work. The delicate enamelling renders it unsuitable for reproduction; we soon, however, come to objects that can be copied.

Amongst the most familiar examples that represent this same century are the standing drinking horns preserved at Queen's College, Oxford, and at Corpus Christi College, Cambridge, and William Wykeham's mitre at New College, Oxford. The piece called the "Giant Salt," bequeathed by Archbishop Chichele to his foundation of All Souls, in the same University, a copy of which we have here this

evening, takes us into the 15th century. Its size and importance reminds one of the honoured place of the principal salt at mediæval feasts, and its cover, and perhaps its material, of the fear of poison under which our forefathers seem to have lived. Not only were salts and drinking vessels closed, but they were often mounted with, or made of, some substance having the supposed power of revealing the presence of poisons. Some kinds of crystals were thought to become clouded, and some precious stones to change colour, if poison were introduced into vessels in which they were mounted.

The Valence Marie, or Founders' Cup, from Pembroke College, Cambridge, is also on our tables this evening, and is an instance of a bowl that probably once was a mazer, but getting broken, and the mottled and veined maple wood of which it was made being difficult to replace, silver-gilt was substituted for wood, and a metal bowl fitted to the original Gothic rim.

These mazers, so much prized by our ancestors, appear to have been merely drinking bowls, though their elaborate ornamentation and enamelled bosses or "prynts" has suggested a doubt as to this in the minds of some antiquaries. The inscription round the rim of the Valence Marie cup is conclusive, running as it does—

"Sayn-denes-yt-es-me-dre.
For-her-lof-drenk-and-make-gud-cher."

The foundress of Pembroke College was Marie de Valence, mother of Aylmer de Valence, Earl of Pembroke. The cup is hardly of her time, but is, perhaps, of the last years of the 14th century.

I am afraid that the space allotted to a paper in the Society's *Journal* will not allow of more detailed notice of these curious and early objects. Others of them upon the table carry us through almost each decade of the late Gothic period, which, for plate-working, ends rather sharply at about the year 1500. There is very little of the *quattro-cento* style to be observed in English goldsmiths' work. The next century is the best period in the history of English art—the Renaissance period—it includes the reigns of Henry VIII. and Queen Elizabeth. The mention of the former may remind us that it was not beneath the dignity of a Holbein to design for the goldsmith, any more than it was beneath an artist so famous as Flaxman late in the eighteenth century.

The Tudor period, again, is represented here by some of its best specimens, including a cup of 1523, given by Henry VIII. to the Barber-Surgeons' Company of London, a work of very beautiful shape and design.

The "Poison Cup," from Clare College, Cambridge, is a good specimen of filigree casing, and the crystal mounted in the lid explains its name.

A most curious cup is one given by Mary Queen of Scots to Perth Cathedral. It is of excellent Nuremberg work, and of about 1560, but the upper part is a Scotch repair, executed, as a well recognised hall-mark upon it testifies, in Dundee about 1637. The end of the century brings us to splendid examples of the ewers and salvers which were so useful before the days of forks. They were handed after every meal, or even every course, with water warm and scented, a not unnecessary custom when lady and gentleman ate with the fingers, helped only by an apostle spoon, out of the same mazer bowl.

I am sorry to say, that the very earliest piece in the Royal Collections at Windsor is no older than this. It is a characteristic salver of 1595, decorated in cartouches with marine monsters, a style of ornament very prevalent for about thirty years. It is by the same maker as a very excellent *repousse* salt at Haberdashers'-hall, the gift of one Sir Hugh Hammersley, in 1635. I am sorry to say, that in the South Kensington Museum handbook it is accidently attributed to this latter year, instead of to the year of its make. The ewer accompanying it is almost exactly like one that is the oldest piece at Eton College, and it is of the year 1614. It is by the maker of the very fine set of communion-plate that belongs to Ladbroke in Warwickshire.

Fine examples, the property of the Corporation of Norwich, illustrate the work of the closing Elizabethan period; and of standing cups there is no better example than the Founder's Cup at Emmanuel College, Cambridge, which it has been the fashion to attribute to the hand of Cellini. It is, however, somewhat too late in date to have been the work of that great master.

Turning over the leaf into the sixteenth century does not bring us at once to any fresh style. The fashions of the Renaissance last us until the severe simplicity of the Puritan *régime* and troubled days end the history of an ornamental art, till the days when the king got his own again, and his followers began to replace the plate that their fathers had sacrified at the bidding of Royalist devotion or Roundhead zeal.

We now come to the notable and much admired specimens of the Charles II. period, the great cups, decorated with the acanthus ornament which was then so prevalent; and the silver furniture, of which Windsor and Knole have furnished the student with matchless examples.

The furniture at Knole was long supposed to have been brought from Spain for the reception of King James I., when upon occasion he lay at the princely home of the Earls of Dorset. It proves by its fashion, when these things became better understood, to have been a set of boudoir furniture made in London; probably on the occasion of a widowed Countess of Dorset remarrying, at a great age, in about 1680, Sir Henry Poole, Master of the Rolls, and Member of Parliament for my own town of Cirencester, near which he resided.

Every later generation is fully represented, bringing us through the plainer styles in vogue at the commencement of the 18th century, to the period we call the Rococo and Louis XV. The former of these epochs, so amply represented by many specimens of French plate, is hardly to be counted as an English period. The later work of that celebrated smith, Paul de Lamerie, who worked in London from 1712 to 1750, show traces of its influence, but traces only. Lastly, the "oviform period," if I may call it so, brings us to the end of the century. The cups and urns of more than one City Company, such as the urn of 1776, belonging to the Barber Surgeons, and a cup of 1795, the gift of one Roberts, to the Merchant Taylors, well represent a style that has been rendered so popular by the pottery work of the great Josiah Wedgwood. The discovery of Pompeii put a summary end to the Louis XV. period, and turned the thoughts of designers into the classical direction which ruled the decorative arts for the last quarter of the 18th century. It is, perhaps, the most familiar style of all to our minds, partly owing to the numberless houses in London that long preserved, some externally and others internally, in their ceilings and their chimney-pieces, the popular works of the Brothers Adam, the builders of the room in which we are now assembled. The next generations are almost blank as far as the history of the art in England are concerned, and I am sorry to have insensibly divided even the last century dealt with into periods marked by French names. The truth is, that France has so stamped the fashions of that century with an individuality of her own, that those names are, in fact, the only ones which recal the fashions they stand for, and describe, without further explanation.

I would here make a remark upon the value of our English series of specimens of old plate as a basis for a work upon what I may call "the chronology of ornament." Owing to the regular system of hall-marking it exhibits, many small mistakes in the supposed sequence of fashion have been corrected, and it is possible to date unmarked specimens, not approximately, as is the case with the sister arts, but almost to a year. The ornamentation in vogue at one period or another is so much the same throughout the whole range of the decorative arts, that from the information supplied by a series of specimens of old English plate, other, and apparently dissimilar, classes of objects may often be accurately assigned to their proper period in art history.

We have now gone through the English series in sufficient detail to understand what has been effected for the history of old English plate; and it is worth saying that only one treasure-house (the situation of which it would be invidious to particularise) was closed by its owners against inspection; their refusal courting contrast with the free permissions accorded by her Gracious Majesty, H.I.M. the Czar of Russia, every college at Oxford and Cambridge, and the greater of the City companies. It may not, after this, surprise the Society of Arts that the refusal was grounded (I am obliged to take it that this was its reason) upon the recent regilding of the collection, and the alleged fear that it might be injured by moulding from its specimens. It is, unfortunately, true that the collection has been regilded; and it is, unfortunately, also true that this same regilding has destroyed a veritable epitome of the history of old English gilding and parcel-gilding, the series having until lately illustrated every phase of this interesting art in the most charming and picturesque manner. It was, perhaps, unique.

Lastly, as regards this collection of reproductions, it may safely be said that it is as valuable and useful, for the purposes of art study, as the original pieces themselves would be. A "type set" is, I believe, kept as complete as possible, at South Kensington, arranged in chronological order, so that one has only to pass down a row of cases to obtain an historical view of four centuries of workmanship at a glance. Each case is conspicuously labelled with the century or shorter period which its

contents illustrate; and the only thing left to be desired, is a system of detailed labelling, which may tell the poor student, who has no handbook, a little more of the history of each object and the reason of its selection.

It is the admirable labelling of some of the museums of the north of Europe, particularly the Hamburg Museum, under the intelligent care of Dr. Brinckmann, that seems almost to have given birth to more than one art-industry that is now flourishing in that city. A school of artists in leather work have obviously drawn their inspiration from the collection of ancient specimens of bookbinding, that owes its great educational importance chiefly to the arrangement and ticketing it has received at Dr. Brinckmann's hands. I wish that time served for a digression upon the subject of museum labelling in general, for it is a subject of the greatest importance, and could be illustrated by reference to many museums and several flourishing industries, some of which I have had an opportunity of inquiring into, in company with my friend in the chair, who feels with me, as I have reason to know.

I am glad to say that the work that we have been reviewing does not stop with England, but that more has been done already, still more being promised. Foreign collections of silver, such as those of Holland and Russia, are so little known, that some account of them will, at all events, be new to some members of the Society. The Education Department has, in the first place, succeeded in obtaining the use of most of the specimens of famous old Dutch art, especially of the days when the Van Vianens and Lutmas carried their craftsmanship to a pitch of technical perfection that has rarely been rivalled elsewhere.

In the spring of 1880, a loan collection of gold and silver work was arranged by the leading artistic and literary society in Holland—the Sociétas Artis et Amicitiæ—in their rooms on one of the quays in Amsterdam. It had influence enough to collect many hundred examples of old Dutch art, most of the municipal bodies in Holland responding to the call, including those of Amsterdam, Rotterdam, Haarlem, Middelburg, Arnheim, Zwolle, Nijmegen, and others. The Royal Antiquarian Society of Amsterdam also contributed its treasures, and the famous collection of H.R.H. Prince Henry of the Netherlands was also placed at their disposal. No less than 24 out of the 97 plates in Van der Kellen's well-known portfolio of etchings of articles of Dutch art-work of all periods and kinds are of objects that were on loan at this time.

Though work of the craft in Holland for the three last centuries was well represented, as might perhaps be expected, there was little to show for any period anterior to the Union of Utrecht, and the Declaration of Independence —say, for the sake of a date, 1575.

In Burgundian times, the art had flourished chiefly in the Low Countries; all the goldsmiths of note in the 15th century seem to have dwelt in Gand or Bruges, and the most northerly place in which the art flourished was Antwerp. Some attention was, however, paid to the regulation of the craft in Amsterdam and elsewhere by the Dukes of Burgundy and municipal authorities early in that century. The Dutch Government, in 1880, used all its influence to obtain the necessary permissions from the various owners, and in the result, some of the very best work in Holland is now at the disposal of the English student.

The great cup of the Arquebusiers' Guild, at Middelburg, is upon the table, and it is a work which will compare well with the most important standing cups of the reign of our Queen Elizabeth. I believe that since the copy was taken, the original cup has been sold by the municipality of Middelburg to a member of the Rothschild family for no less a sum than 15,000 Dutch florins, or £1,250.

The most popular form of Dutch cup in the 18th century seemed to be tazze, "drinkschalen," like the one which shows the face of William Courten looking through a barred prison window. It is Middelburg work of 1567. Courten was one of the victims of Alva.

The standing cups of the period must not be passed by without special mention of the cup formerly of the Brewers' Guild at Haarlem, now the property of the municipality. It is justly valued, and all the records relating to its making, in 1604, and cost have been carefully preseved. The group of St. Martin on horseback, with the beggar on the cover, is executed by Ernst Janss Van Vianen, member of a celebrated family, from a design by Hendrick Keyser, sculptor, of Amsterdam. The medallions on the side of the body, representing incidents from the life of the saint, were designed by Hendrick Goltzius, and, like the group, executed by E. J. Van Vianen, whilst the body of the cup, its foot, and cover, are the work of one Jacop Alckema, goldsmith of Haarlem, whose mark, and the other Haarlem marks for 1604, it bears in two places. There is a fine "presentoir" of about

this date from the municipal treasury of Amsterdam. It illustrates the luxury of the wealthy Burgomaster, who would not deign to receive his cup from the hands of his server, but had it handed in one of the costly and finely wrought stands or handles, called in Dutch, "Bekerschroeven."

Of the year 1610, was a small cup of pure gold, belonging to Prince Henry of the Netherlands, the work of Paul Van Vianen, or De Vianâ, a still more famous artist than Ernst Janss Van Vianen; its body is chased with classical subjects, executed in very beautiful low relief. To him we owe, too, the figure of Atlas from the Trippenhuis at Amsterdam.

The most important pieces of all were somewhat later in date, being the splendid salvers, ewer, and candlesticks bequeathed to the Hospital for Incurables at Marssum, near Leeuwarden, in 1712, by its munificent founder, Dr. Popta. They are of earlier make, but they exhibit a mastery of the technical art of silver working that is almost matchless. They are by some Leeuwarden artist, whose name is unknown, his mark "meister-teken" is a cup, but the cartouches of the basin are designed by the same Hendrick Goltzuis who has been mentioned in connection with the Haarlem cup. A smith of wonderful skill, named Baardt, worked at Bolswardt. A specimen of his work is at our disposal this evening.

With these few and inadequate remarks, the interesting Dutch collection must be left for a more important subject (though not more important as matter of art history), viz., the Imperial treasures of Russia. Permission was in the same year, 1880, received from H.M. the Czar to inspect, and select from, the hitherto utterly unknown treasures of the Winter Palace at St. Petersburg, the Imperial Museum of the Hermitage, the celebrated monastery of Troitsa, and, above all, the collection in the Kremlin, at Moscow.

Of those it was only known by rumour that they were rich in specimens of English plate, of great size and antiquity, some of them said to have been taken to Russia by the Czar Peter the Great himself from England; but they had never till then been examined by any expert, nor were their contents understood even by their own custodians. It was, therefore, full of eager curiosity that an expedition from England started on this interesting tour of inspection in the autumn of that year, our chairman and myself being of the party. To describe the collections that we eventually examined in detail would take much more than one paper to describe; suffice it to say that much massive English and other plate was discovered, but none that seemed to have been taken home to Russia by Peter the Great. The English specimens in the great treasury at Moscow seemed to have been presented by several English sovereigns, including Queen Elizabeth and her successors, the most modern of the pieces being from Charles II. on the occasion of the Restoration. These last were sent by the hand of his ambassador, James, Earl of Carlisle, in 1663—some of them are on the table of the Society this evening. The curious fact came to light, on a careful examination of the hall-marks on the English pieces in the collection called that of "The Patriarch of Moscow," also preserved in the Kremlin, that whenever a grand present had been sent to the Czar of Moscow, a corresponding but smaller offering had been presented to the Patriarch, showing the great importance of the latter office, and perhaps explaining its abolition by Peter the Great. Even now, the Holy Synod, which replaced the Patriarch, is addressed in the second person as "Your Holiness," and represents his personal authority over the Greek Church. The native Russian specimens were either very old or comparatively modern. The ancient are the golden ornaments that have been mentioned as Scythian, or Græco-Scythian, and are of a period far anterior to the Christian era; and the modern are the drinking bowls and ladles, called "Bratinas" and "Puisoirs" respectively, that almost exclusively represent the purely Russian art of the 17th century.

If we add to the English, Russian, and Dutch collections a number of the best known specimens of German, and a few of French work that have been recently acquired, the South Kensington Museum is within measurable distance of being able to show the foreign visitor a series of the best pieces of plate in the public and private collections of his own land, much more easily than he could see them at home, if, indeed, he could obtain access to some of them at all. Without having quite reached this point yet, we have, at all events, been able to sketch out the complete history of English plate-working, and to find out much about foreign work, as it is illustrated by reproductions of many of the very best specimens of the remaining work of the several countries that have been mentioned. These specimens can be arranged in strict chronological order, not only by their fashion,

but by the aid of their hall-marks; and, even as far as it goes, the series is one the like of which is at the command of no other art or trade. No art-manufacture has a longer nor more distinguished history, nor one better worth the study of the present generation of craftsmen.

I will conclude by expressing a hope that future generations of English artists in the precious metals will take rank with the best of those which have preceded them.

Had time permitted, it would have completed the consideration of our object to have turned to a different aspect of it altogether for a few moments, and noticed the fiscal and other questions of the day that relate to the craft, viz.:—The plate duties, our system of hall-marking, and the constitution of the Goldsmiths' Company.

Although I do not think that either hall-marking or the plate duties prejudicially affect the craft to any appreciable extent, questions relating to them are very persistantly kept before the public.

As regards the plate duties, whilst it may be admitted that the remission of any tax upon any trade must be, of course, in itself an advantage, it is very questionable whether it is wise to keep a constant agitation on foot, in season and out of season, for such remission. No harm that the plate duties have done the plate trade can compare with the baneful result of constant agitation that has been kept on foot by a few persons for their abolition.

It is clear that the present time is not a favourable one for demanding the remission of a tax upon a luxury. The prices that are charged for articles of silver work (I mean works of art) are so high, that the duty payable upon them is but a small part of their cost; and it is worthy of note that, within the last few years, the price of silver has dropped by a tangible portion of the amount of the duty so bitterly complained of, without bringing about the expansion and revival that would be the result if the duty of itself caused depression. The fact is, the intrinsic cost of the metal is so great, that no small difference in the price of silver, such as would be the result of the abolition of the duty, would bring it into competition with a rival which is of no intrinsic value at all. A man who can afford to pay £11 a dozen for spoons or forks, can equally well afford to pay £12. If he wants a salver for a present, or a testimonial, it makes no practical difference to him whether its price is £190, £195, or £200. The class of people who buy silver plate are not affected by the amount of the plate duty. If the fashion of the day dictates the purchase of antique instead of new plate, they cheerfully give its weight in gold for it, and in any quantity.

Much more strongly I would urge that the simple and consecutive system of compulsory hall-marking that has obtained for so many centuries should not be lightly abolished when it is found possible to remit the plate duties. Whatever may be said against taxation, it is really absurd to urge that hall-marking is any real or serious restriction upon trade, and it may be that those who are responsible for keeping on foot the twin agitation may have reasoned that, as the duty is collected at the same time as the hall-marking is effected, and would be very difficult to collect otherwise, an agitation that could be successfully carried on against hall-marking would very likely soon carry with it the abolition of the plate duties. Those who press for the abolition of the hall-mark, dwell upon the injury done by stamping the articles submitted to marking. They seem to forget that silversmiths themselves would have to mark their own wares with as many, probably more, detailed marks. As long as silver has to be valued for probate and legacy duties, some well-known public mark must be used, unless the appraiser is put to the necessity of causing an assay to be made in every case of disputed opinion as to quality. It will hardly be urged that the name of any individual silversmith or firm, however well-known to-day, but which will be forgotten in a few years to come, would answer the same purpose as the simple lion *passant*, and the other marks of the Goldsmiths' Company, even if such private name were to be stamped in conjunction with the words "sterling," "18-carat," "22-carat," or the like.

Lastly, those who urge the abolition of compulsory hall-marking are either ignorant of, or else carefully conceal the fact that, even free Switzerland—the freest of Continental nations, and the most intolerant of any such trade restriction—has had, after a fair trial of voluntary marking, to re-impose compulsory hall-marking throughout the Confederation within the last year or two. They also do not let us know that there is a constant agitation going on in America for the establishment of some simple and state—or, at all events, guild—system of hall-marking, such as that of which they so persistently advocate the abolition in

England. I, for one, hope that we shall not be so unwise as to follow the example of France, where a system of consecutive hall-marking was abolished in 1783, only to lead to the re-establishment of hall-marking minus a year mark in 1791. From that time to this France has been restlessly changing its marks every twenty or thirty years, till she has combined as many of the disadvantages of compulsory hall-marking with as few of the advantages of our own time-honoured system, as could be desired by the most ardent Republican, loving change for its own sake.

Some people seem to forget that a trade, after all, exists for the public, and not the public for the trade; and in this case they count for nothing the value—the high value—that the public are wont to place upon the hall-mark as a guarantee and as a protection against fraud, if it gives the tradesman any trouble to obtain it. It will not be contested, even by them, that manufacturers are now obliged to get all sorts of insignificant articles stamped that are legally exempt from liability to marking, owing to their small weight; for example, the corners of pocket-books and purses, articles which, twenty years ago, nobody would have thought of hall-marking, but which now command a better price for being so guaranteed.

I noticed a letter in print not very long ago, which ended with the significant words:—"The public protect themselves as far as all other trades are concerned. Why not in the case of silver goods?" I suppose that the writer of the letter I have just quoted would say that if I want a new decanter for my sherry, and a new silver jug for my claret, I am as good a judge of the quality of the material in the one case as in the other, and as little liable to be defrauded. I do not think so, and I am the best judge of my own ability in this matter. The value of a glass decanter to a purchaser depends upon whether its shape and appearance suit him. He can judge of the transparency of the glass, and its freedom from flaws for himself. Is there really nothing beyond this that he would care about if he were buying a silver claret jug, nothing beyond what he can see for himself? I think that any one who could insist that this is so, would probably beg the question and say in reply, "Well, take the case of diamonds," or something equally beside the point.

No one who knew little or nothing about them would buy diamonds without professional advice; and partly just because they cannot be certified, by any such plan as hall-marking to be what they are represented to be. They are only occasionally bought, and by the very rich, and they may just as well be bought on such occasions under the advice of an expert. Can this be said of articles of silver, required constantly, and though of intrinsic value enough to require some regular and simple certificate of quality, not of sufficient value to make professional advice seem indispensable? I think that if silver were not hall-marked, it is still of sufficient intrinsic value to require some other guarantee, and I think the habit that would arise of calling in some expert on the occasion of every large purchase, would soon be found a greater restraint upon the trade than the trouble of getting the goods marked in a way that the purchaser is found, in practice, to accept without hesitation as a guarantee of their quality. The public would certainly and sorely miss the lion *passant* and leopard's head crowned, from the wares of those who did not avail themselves of a system of voluntary hall-marking at Goldsmiths'-hall or elsewhere, that would in any case have to be substituted, even if compulsory marking came to an end; and such persons would, in effect, either have to use the voluntary hall-marks as regularly as if they were compulsory, or to see their business go into other hands. This would very soon result in the old system of compulsory hall-marking being re-established by common consent, with all the disadvantage of leaving a break in the continuity of an interesting history which has lasted, at present, uninterrupted even by the events of the most troubled times, for upwards of 400 years.

I have occasionally seen the complaint carried further, and made to include not only the system, but the constitution and composition of the Goldsmiths' Company, whose duty it has been, for ages, to impose the hall-mark, and otherwise regulate the trade. It is for example objected that its governing body are not all silversmiths, but that certain members of its court are drawn from other classes of the community. Here, again, the public and public interest is ignored, and the matter regarded from the narrow point of view of some one personal interest. I have no doubt some people think that all the governing body of the Goldsmiths' Company ought to be manufacturers or sellers of silver ware. They could certainly then manage the trade and hall-markings, and the revenues of the corporation

also, their own way, and form a very comfortable and close borough. But I do not see what ground the public would have for their present confidence in it. Such corporations exist in these days for the public good, or not at all; they have ceased, and rightly ceased, to be mere trade protection societies. Considering the national importance of the Goldsmiths' Company, with its great revenues and estates, its varied duties and responsibilities as regards the coin of the realm and the protection of the public, and—I will even add—the trade, I think this Society will be of opinion that the composition of its governing body is wisely enlarged, so as to include bankers, merchants, gold-refiners, lawyers, and others, as well as manufacturers or dealers in silver ware. A cry that it ought to be constituted exclusively, or even almost so, of the latter, can only be raised in the hope of destroying it altogether. It would certainly rid some people of my acquaintance of a supervision that is at present an uncomfortable check upon their business operations.

I have now noticed the questions which are kept before the public, and which are annually forced upon the attention of the Government of the day, by persons professing to represent the interests of a trade which almost entirely disowns them, and which cannot but find by sad experience that the agitation, far from doing it any good, has upset it most seriously by the uncertainties it has occasioned. It may be admitted that, theoretically, compulsory hall-marking can be made a grievance, just as compulsory vaccination can, and some other incidents of modern legislation which I need not particularise. The very objections that are raised to them, all seem of themselves to suggest the necessity of more careful, judicious and regular application, rather than their abolition; until we can indulge in the freedom which would work well enough in Utopia, and will obtain, no doubt, under the millennium, when taxes will be unnecessary and dishonesty unknown.

DISCUSSION.

Mr. WATHERSTON thought it would have been better if Mr. Cripps had not written the last part of his paper. If he had given the smallest attention to the most elementary work on political economy, he would not have done so. Mr. Cripps said it was questionable whether it was wise to keep a constant agitation on foot, in season and out of season, for the remission of the plate duties, but he (Mr. Watherston) thought otherwise. As to the statement that the agitation had been kept on foot by a few persons, he had always found that agitations were conducted by a few persons, and when they had justice on their side, the agitations invariably were successful. Again, it was stated that the present time was not a favourable one for demanding the remission of a tax upon a luxury, but the most elementary work on political economy stated that a luxury differed in no sense from a necessity; both had an exchange value, and the one was equally, if not to a greater extent, an addition to the wealth of the world; therefore there was no sort of principle in a tax upon a luxury. As to the statement that a man who could afford to pay £11 a dozen for spoons or forks could equally well afford to pay £12, he might say that the reader of the paper evidently did not know the value of spoons or forks per dozen, or the amount of the duty upon them, because the duty upon these articles was just one-fourth of their value, so that a person, instead of having to pay £12, would have to pay £16. Further on, Mr. Cripps said, "Whatever may be said against taxation, it is really absurd to urge that hall-marking is a fatal restraint upon trade." Again, the voice of political economy was clear that all restraints upon trade were fatal to trade. John Stuart Mill said:—"It is a well known fact that the branches of production in which fewest improvements are made are those with which the revenue officer interferes, and that nothing in general gives a greater impetus to improvement in the production of a commodity than taking off a tax which narrowed the market for it." In another essay, he said:—"Any regulation whatever, enforced by law, makes it difficult for the producer to adopt new and improved processes;" and then he denounced all interference by the State in matters of harmless trade. There were other passages to the like effect which he would not detain the meeting by quoting; but he might say that he should take the opportunity of answering the statements contained in the paper at the meeting of the Social Science Congress, to be held at the end of the year. As to the statement that it would hardly be urged that the name of any individual silversmith or firm, however well known in the present day, but which would be forgotten in a few years, would answer the same purpose as the simple lion *passant*, he might remind Mr. Cripps that he himself told the meeting that he had been able to fix the date of a very old piece of plate merely by the initials of the maker which he found upon it, so that the objection would not hold good. The dates of many of the most magnificent works of art in the South Kensington Museum had been fixed, notwithstanding there were no hall-marks upon them. In the case of gold, the hall-marking was entirely voluntary. No one desired to sweep away hall-marking entirely; what was wanted was a reform in the law. There was an absurd impression abroad that hall-marking was instituted to protect the public, but it was nothing of the sort. The origin of hall-marking was this. Edward I.,

who was always in debt and at war, objected to the export of bullion, and, on the other hand, the goldsmiths of London wanted protection from foreigners, and, in fact, from anyone outside the city walls, and they entered into a contract with the king by which he obtained money, and they got protection. Unhappily, the law then made had prevailed down to the present time. The silver trade was the only protective trade in the country, and it reminded him of the words of Schiller, "Time consecrates, and what is great in age becomes religious." He was afraid it was in that spirit Mr. Cripps had touched upon the question of hall-marking. The agitation for the repeal of duty upon silver plate would not cease until the duty had been abolished, and directly the duty was taken off, agitation would commence for the repeal of the law as to hall-marking.

Mr. Martin Wood thought every one must appreciate what had been done by the authorities in the way of art-teaching, but he held that the retention of the fiscal system was checking the true growth of educational art. This fiscal system excluded the many beautiful varieties of Indian art from becoming well-known as articles of commerce, and, therefore, he could not conceive why agitation for the repeal of the duty should not be persisted in. The monetary result obtained from the duty was contemptible as compared with the result of the trade. Upon the vexed question of hall-marking, he thought it was a curious fact that hall-marking on gold was not compulsory. No doubt it was desirable that there should be some authoritative and easy method of testing articles, and an official method could very easily be instituted, such, for instance, as the option system of Ameriea. In his opinion, the operation of the enormous duties was to place an embargo upon genuine artistic articles, and to prevent freedom of trade in electro-plated goods.

Mr. Streeter said it was compulsory that certain articles made of gold, such as wedding and mourning rings, should be hall-marked. There was no doubt that the laws as to hall-marking needed reforming, in order that a stop might be put to forgery of marks on plate. The Goldsmiths' Company had a law whereby they were bound to see that no forged plate was in existence, but this duty they neglected. He should be glad to see the duty on silver repealed, but still he thought that hall-marking on gold should continue.

Mr. Liggins hoped that the paper which they had heard that evening would be published in a pamphlet form by the authorities at South Kensington, as he understood the paper was on art plate work, and not upon ordinary articles of plate, such as spoons and forks, which were made in England for all other countries. The public had a right to have sterling silver guaranteed by a hall-mark of some high authority, so that they might not be deceived into purchasing white metal with a thin coating of silver upon it. To his mind, that was one reason why hall-marking, which had existed for 580 years, should be continued. When two eminent Chancellors of the Exchequer had proposed to deal with the question of the silver duty, the trade, and the working men in the trade, had petitioned against it, and consequently, the measure was withdrawn. He thought the late agitation had depreciated the price of silver to a most alarming extent, and only the other day he received a letter from India announcing the death of an officer, in which the following statement was made: "He died from a fever, caused by the further depreciation in the value of silver, and from the fretting consequent upon the depreciation of the value of the dollar." This depreciation was a serious matter to persons in India, as they only received £80 for every £100 they earned. As an old merchant, who had paid enormous sums to the Government for duty, he might say that the agitation about the silver duty was the greatest curse to the trade.

Mr. Garrard wished to correct a statement made by the first speaker, as to the duty being one-fourth of the value; spoons of the value of £12 would weigh 30 ozs., and the duty upon this would be not more than £2 5s. He thought that nothing could be more unjust than that a person who made his living by a trade should agitate to do harm to the trade. The persons who most suffered by the agitation for the abolition of the duty on silver plate would not be the masters, but the workmen. It was not correct to say that the hall-marking of gold was entirely voluntary, for it was demanded by law just the same as it was upon silver, though the exceptions were much more extended. He could speak from experience in the matter, as he paid large sums annually for this purpose, and he was not likely to do so if he were not obliged. The time-honoured system of hall-marking had been of great advantage, and was a guarantee to the public who bought silver ornaments. As the rules under which hall-marking were carried on were made many years ago, it was no wonder if they now required some alteration. With such improvements as might be found to be necessary, he hoped the system would long continue to be compulsory.

Mr. Cripps, in reply, said that the first speaker had quoted John Stuart Mill to prove that taxation acted as a restraint to trade, but he had never said anything to the contrary, and he could not quite see what the remarks had to do with compulsory hall-marking. With regard to what had been said as to the origin of hall-marking, and that it was started for a very different purpose, that might be quite true, but things which were commenced for one purpose, very often came to answer a different purpose at another time.

The Chairman said that, for the last four or five years, the authorities at South Kensington had been

endeavouring to accomplish a work not only of great importance to that museum, but with a view of furnishing articles of art to local museums, which he was happy to say were spreading all over the country. He claimed for the work done by the Lords of the Committee on Education even a wider sphere than this; what had been done for the museum at South Kensington and the local institutions, had been done for the benefit of museums throughout the world generally. It was in the pursuit of this particular work that they had had the benefit of the gratuitous services of Mr. Cripps, and without the special knowledge possessed by that gentleman on the subject of plate, it would have been impossible for the authorities to have made a selection of plate from different countries. In company with Mr. Cripps he had visited Russia, Sweden, and Denmark, and as the result of their visit, a large number of reproductions of the plate of these countries would shortly be ready for exhibition. He thought it was only right that they should pass a hearty vote of thanks to Mr. Cripps for the important services he had rendered, not only to the public, but to the trade, for his treatment of this subject in a manner which had never before been done. He had much pleasure in proposing a vote of thanks.

[The paper was illustrated by a large collection of reproductions of historical pieces of gold and silver plate from the South Kensington Museum, lent by the Lords of the Committee of Council on Education.]

Miscellaneous.

THE INTERNATIONAL FISHERIES EXHIBITION.

The above named Exhibition at South Kensington, which will be opened to-morrow by H.R.H. the Prince of Wales, and remain open for six months, is likely to justify its title, as far as can be judged by the number of exhibits it contains, and the variety of countries which contribute them. Like other public Exhibitions, it will partake somewhat of the character of a pleasure fair, and it is expected to be one of the fashionable lounges of the London season; but it will also be an event of national, and indeed of international, importance. Fish, both salt-water and fresh, being a favourite food of all nations that can command a supply of it, all matters connected with it must necessarily be of interest, and its capture, distribution, and price must always command attention. Previous Fisheries Exhibitions, of late years, at Berlin, Edinburgh, and Norwich, have already effected much practical good, or at least have opened the way to it, and it is not unreasonable to expect that the present, as being the largest and most comprehensive of its kind yet held, will be still more productive of good results.

The exhibits at South Kensington are divided into seven classes — No. I. embracing Sea Fishery and Fresh-water Fishery; II. The Economic Condition of Fishermen; III. The Commercial and Economic Aspect of Fishery; IV. Fish Culture; V. The Natural History of Fish; VI. Fishery Laws, Fish Commerce, &c.; and, VII. Loan and other Collections, illustrating the subjects of the foregoing classes. The sub-divisions of these classes number no less than sixty-one, and embrace almost every subject that can directly and indirectly be brought within their scope. To turn the exhibits to practical account, conferences will be held at the Exhibition for the purpose of reading and discussing papers on a variety of subjects arising out of the Exhibition. And thus it may be hoped that full light will be brought to bear on the intricate question of the fish supply, and the influences exercised upon it, and the consequent retail price of fish. Pisciculture, and the acclimatisation of foreign fish in our waters, will also be dealt with, and the cognate subject of the pollution of rivers, which is now before the Legislature. Fish diseases, and especially that of salmon, and their remedy, will receive full discussion, and fresh legislation in a variety of directions, with a view to increasing our fish supply, will be proposed. Something like a score of prize essays, for which considerable sums of money have been offered, will contribute to the general stock of information and suggestions; and thus the whole subject of our fisheries will be thoroughly dealt with.

Later on in the season it is proposed to publish in the *Journal* some further articles upon the Exhibition.

BUILDING EXHIBITION.

The Fourth Annual Building Trades' Exhibition was held in the Agricultural-hall, from 2nd to 14th April. There were nearly 400 exhibitors; and the exhibits filled the body of the hall, half the galleries, King Edward's-hall, and the Arcade entrance.

With regard to bricks, both plain and ornamental, a new and pleasing buff tone was noticed at several stands, obtained in one case by stopping the burning at an earlier stage than that necessary to produce the Staffordshire blue brick. Some very elaborate forms of moulded bricks were also shown, especially by F. Rosher and Co., who claim that they afford the cheapest effective means of architectural ornamentation. On the other hand, a great many firms showed soft bricks of uniform texture, which are capable of being sculptured after they have been laid, and the mortar set. The most striking illustration of this kind of work was the stand of T. Lawrence and Co., with the Royal Arms cut out of brickwork a fortnight after it had been laid, and the finials

turned in the lathe. The new "Glogue" bricks were shown by Jas. Owen, which are found by Mr. Kircaldy to possess a crushing strain equal to that of granite, while they are remarkably compact, heavy, uniform in texture, smooth and regular on the surface, are impervious to water, and resist extremes of temperature.

A demonstration was made during the Exhibition of the value of W. White's "Hygeian Rock" composition applied to brickwork, for the double purpose of increasing the strength and of keeping out water. A beam of brickwork, two bricks thick, with a layer of about an inch of composition between them, resting on supports 5 feet 6 inches apart, which had, up to the trial, sustained a weight of 8½ cwt., was loaded to the centre with nearly 1½ tons without breaking. Some reservoirs were formed of brickwork, with a layer of composition between the inner and the outer courses; they were filled with water, which completely saturated the former, without penetrating to the latter. Engert and Rolfe also put up some brickwork with a damp course of their fibrous asphalte, which was surrounded by water to show its efficacy. Besides being impervious to wet, the asphalted roofing felt of this firm is claimed to be a non-conductor of heat, and, therefore, to serve admirably for laying under slates or tiles, and also for nailing under rafters in a slate or tiled roof. A. Haacke and Co. showed applications of their carbonised tar, which, while retaining a certain amount of elasticity, soon sets firm on the outside, and, being waterproof, appears suitable for coating all structural materials. The Indestructible Paint Company showed various natural stones, treated on one side with Browning's preservative solution, which has been applied to Cleopatra's needle. It does not alter the colour, even of white marble; and its damp-proof properties are ocularly demonstrated.

Some good specimens of natural stone were exhibited, notably that of the Mangotsfield Pennant Stone Company (Limited), which, largely used in the West of England, merits more extended application, and also the Belgian "T" marble, imported by A. Tagnon. Numerous, too, were the examples of artificial stone, the great advantage of which is uniformity of structure, and the absence of "bed." The Patent Victoria Stone Company exhibited specimens of their flagging as laid in London, and also some, broken to show the grain, that have stood five and eleven years' wear in crowded thoroughfares. There were also railway platform noseings, wall copings, and window sills of this stone, which, it is asserted, increases in hardness, does not effloresce, and is washed clean by the rain. The products of the Imperial Stone Company, Limited, adopted by the Metropolitan Board of Works, differ from others, the mixing being effected by machinery, thus ensuring uniformity of composition. The crushing strain is found to be 8,075 lbs. per square inch, and the tensile strain 792 lb. per square inch. Some drain-pipes, made from Thames ballast by this process, and afterwards turned in the lathe and polished, presented a remarkably fine grain, resembling a light brown marble from which mantelpieces are frequently made. Specimens of Scagliola marble, an old Italian manufacture revived, were shown by Bellman and Ivey. Enamelled slate was contributed by several firms, notably Joseph Brindley and Co., Government contractors, got up in such perfect imitation of various marbles, as to require a very close inspection to detect the counterfeit.

Fireproof ornamental construction was a great feature at the Exhibition. Doulton and Co. showed artistic chimney pieces, in fireproof and comparatively inexpensive materials, including Doulton ware, Lambeth faience, and glazed terra cotta. Besides terra cotta statues, of remarkably uniform tone, Joseph Stiff and Sons contributed an elaborate cornice in this material, with sharp inside and outside angles, and generally great sharpness of ornament, not at all warped in burning. This is the great difficulty that has hitherto attended all efforts to produce large pieces in terra cotta; and it is this which has led W. H. Lascelles and Co. to manufacture such pieces in concrete, coloured in the mould to represent red terra cotta. Their mullion and Gothic windows, and also chimney-pieces, built up of the large concrete blocks, are successful; while the specimen shown of enriched gallery front, for the Epsom Town Hall, proves that good ornamentation, combined with safety from fire, can be secured at a moderate cost. Another instance of this is afforded by the specimen of proscenium in marble mosaic concrete, for the new "Grand" Theatre, Islington, exhibited by Charles Drake and Co. The Eureka Concrete Co. showed a staircase landing without stiffening iron, a stable flooring, a dormer window, with centre mullion, and a fireproof door in concrete.

Fibrous plaster appears to be a new material called into being by the necessity of guarding against fire. Webb and Co. showed dados, cornices, and pilasters, as well as a whole ceiling in this material, and also the reproduction, in carton pierre, of an elaborately carved oak chimney piece, while they modelled architectural designs in the presence of visitors. The Papier Maché Co. showed the decoration of three sides of a room, and also ceiling, cornice and dado in papier maché and fibrous plaster. Hitchin's Patent Plastering had on view their plaster slabs, free from lath, and lime, and hair process, ready to be nailed up and receive a finishing coat. Their fireproof quality was shown by a slab taken from the demonstration fire at Whitehall, in 27th February last. The plastering done by this firm is laid on wire netting. Perforated zinc is used for the same purpose by R. W. Hall and Co. The canvas and plaster exhibits of Allen and George include plain and enriched cornices and overdoors for the London and South Western Bank at Peckham, and a panelled ceiling with dentelle cornice for Geo. Rowney and Co. Frederick Jones and Co. showed various applications of "silicate

cotton," or "universal wool," made from blast-furnace slag, by Mr. Charles Wood's process. Being a capital non-conductor of heat and sound, it is used with advantage in pugging floors, fireproofing buildings, lining refrigerators, packing gas-cooking stoves, and covering steam pipes and boilers.

Hall's patent hanging tiles, various specimens of which, plain and ornamental, were exhibited, but all glazed, form a neat and cleanly lining to old brick walls; they are made to course with brickwork, and are attached by two nails driven into the joint. Or they may be used to advantage for lining temporary wood partitions, giving all the appearance of a brick wall. The Bracknel Pottery Co.'s roofing tiles afford a weather-tight lap without mortar joint, an arrangement which is also adopted at the eaves of gable-ends. John Mathews put up a light structure, roofed with Poole's bonding-roll tiles, which afford a capital covering, proof, it is asserted, against all weathers. W. Hale and Co. showed a new system of zinc roofing, in which the metal is laid without any soldered seams, and, in a succession of steps, made to overlap with a locking joint, to keep out snow.

CULTIVATION OF THE POPPY IN ROUMELIA.

H.M. Consul at Salonica mentions in his last report that there are few industries in European Turkey, certainly none in Roumelia, that have been so successfully introduced and prosecuted as the cultivation of the poppy. The first attempt to grow the plant in the province of Roumelia was made about seventeen years ago, by a Turkish farmer at Istip, with a handful of the poppy seed, which he had brought from Kara-hissar, in Asia Minor; the experiment proved a complete success, and was renewed on a larger scale in the following year, 1866, since which the production of opium has annually increased and flourished in Istip, and the adjoining districts of Radovitz, Kotchan, Stroumnitza, Tikvish, and Kinprulu-Veles. The Roumelian opium, especially that produced in the district of Istip, is very pure, and contains about 11 per cent. of morphia, while that of Smyrna contains scarcely 9 per cent., and is considered equal to the Malatia produce. In the year 1882, the production of the province amounted to about 135,000 lbs. of opium and 5,600,000 lbs. of poppy seed, most of the drug being exported to England, and about 4,000,000 lbs. of the seed being exported from Salonica chiefly to Germany and France. The Turkish Government, with a view to encourage the development of this industry, remits the tithes on opium and poppy seed for one year, in the case of lands that are sown for the first time with poppy seed, and distributes in the agricultural districts printed instructions on the process of cultivating the poppy, and extracting and preparing the drug from the juice. It appears from these instructions that the *khash-kash*, or poppy seed, is sown from the month of September up to March, in localities where there is no hoar frost in spring and autumn but in places where there is hoar frost, the seed must be sown in the month of September, and in the spring, after the chilly weather is passed. The soil selected is generally light, rich, and yielding; if the seed is sown in cold clayey soil, or in damp localities, the yield will be small, and the opium of an inferior quality. The ground is always well manured, and experience has proved that if a field which has just yielded a crop of opium be immediately sown with wheat, the crop resulting from this last sowing will be remarkably good. The soil of a field to be sown with poppy seed is ploughed two or three times, and well broken up. The seed is then scattered about with the hand; after this, the soil is again thoroughly stirred up and mixed by a rake, or a row of bushes bound on to the back of a harrow. As soon as the young poppy plants begin to appear above the surface of the soil, and to bear three or four leaves, in places where they are too close together they are taken up, and planted again in such a manner as to leave a space of a span between each plant, and the soil hoed two or three times to remove any weeds that may appear. Opium being a substance which is extracted from the pods or outer shells of the poppies, as soon as these pods become green in colour, and have reached their full growth, the green hue changes to yellow. A few days before this change of colour takes place, there forms over the pods a thin watery film of a light green hue; this film is called *cougak*. If it be wiped away with the finger its place still remains visible, and if at this time the pod be squeezed between the finger and thumb, it becomes so far strengthened that it cannot be easily crushed. It is at this time that the juice which forms the opium is gathered. In order to gather the juice or paste, an incision is made in the pod, beginning from the middle and going round the edges, at the same time leaving a space of about a finger's breadth, with a knife made expressly for the purpose, being small and sharp-pointed. Immediately this cut is made, there appears a white milky fluid of a bitter taste. This fluid gradually increases in consistency, and its colour becomes darker, until, in twenty-four hours, it is coffee-coloured, and as thick as paste. This is scraped off with the edge of a somewhat large and blunt knife, and put into a poppy leaf, and this is done until about twenty or thirty drachms of opium have been collected on one leaf, the edges of which are then turned in so as to prevent it being spilled. If while the opium is being collected, the film be mixed with it, it has a beneficial effect. The work of cutting lines in the pods of the poppies is generally commenced early in the afternoon, and continued until nightfall. As the opium must be collected twenty-four hours after this operation has been concluded, the labourers commence on the following day,

soon after twelve o'clock, to collect the opium from the pods which were cut the day before, and also to make incisions in other pods. Any pods which are not quite ripe, are left until they become thoroughly ripe and fit for cutting. In order that the exact season for collecting the juice may not be missed, the whole work must be performed in eight or ten days, and the proper time for marking the pods must be accurately ascertained, for if the pods be cut before or after they are quite ripe, there is no yield of opium. Great care is taken not to cut the pods while a high wind is blowing, or when it is raining, as in the latter case the rain washes away and destroys the juice as fast as it exudes from the seams that have been cut for it. After the opium crop has been gathered in, the pods change their previous hue, of either green or yellow, to rose colour; when this change takes place, the plants are taken up by the roots, one by one, and collected in small bundles. Each bundle is then bound by a young green withe, and so placed upright in the ground that the roots of the plants are covered, in which position they remain for a few days, until the seed contained in the pods becomes thoroughly dried and matured. The pods are then threshed with a stick until they break open, when the seed is collected. Another method which is often employed, is to sever the stem of the plant at the knot which is found close up to the pod with the finger and thumb, and after collecting the ends so severed, to spread them out to dry in some open place, and then to break them open by threshing, or else to pull them to pieces, and after sifting the seed until it is quite free from extraneous matter, to collect it. At Kara-hissar, most of the pods are burned to reduce them to ashes, and a fluid is extracted from them, which is used to bleach cotton, as it is considered more effective than the water which is strained off from ordinary ashes. After extracting the oil from the poppy seed, there remains a sediment technically called *kyusebe*, on which buffaloes, cows, and black kine generally, are fed, on the ground that such diet increases the amount of milk given.

NEW ZEALAND TIMBER SUPPLY.

The United States Consul at Auckland, writing on the trade and industry of New Zealand, says it is estimated that the forests of New Zealand cover an area of not less than 20,000,000 acres, the forests on the Crown lands alone being estimated at 10,000,000 acres; about 5,000,000 acres are the private property of the white or European population, and the remainder is by the Maori, or native inhabitants. Among the many descriptions of timber grown, the *Kauri* pine is considered one of the most valuable; it is found only in the province of Auckland, and in that district it does not exist further south than the East Cape, and, like the cedar, it is confined to the vicinity of the sea. The kauri forests cover about 60,000 acres of Crown land, and about 120,000 acres of private property. The trees often grow to a height of 200 feet, and measure from 12 to 30 feet in circumference; they are discovered occasionally with a rugged surface, and on being cut, the grain is found to be mottled. The kauri is exported largely in what is called "junk," the logs being squared with an axe, thus wasting a quantity of good timber. The annual output of kauri timber is about 110,000,000 feet, and the highest estimate of the amount of timber left in the kauri forests is 23,000,000,000 feet. The subject of conserving the kauri forests is at the present time attracting considerable attention throughout the colony, not only on account of the excellent timber it produces, but on account of the gum which exudes from the tree, and which for many years has formed the most valuable article of export of the province of Auckland. Next to the kauri, the *Kahikatea*, a species of white pine, is the most highly prized. It grows in the low lands in the vicinity of rivers. There is an immense forest of these trees between the Thames and Piako rivers, thirty or forty miles in length, and several miles in breadth. The kahikatea is found in the kauri districts, and but little attention is paid to it, notwithstanding the fact that its value, as a timber for building purposes, is becoming very generally known. *Totara*, a hard close-grained wood, is largely used in the south of New Zealand; it is a good sound timber, reddish in colour, and very durable. It is largely used for telegraph poles, and has attracted much attention during the last few years, from the fact that it will withstand the disastrous ravages of the *Teredo navalis*, a sea parasite, common to the islands of the Western Pacific. *Puriri* is another hard durable wood; it is largely used in the construction of railway trucks. This wood is said to make excellent furniture, though it is not much used for this purpose. Another very valuable timber tree is the *Maire*, a native olive. It is hard, oily, and close-grained. *Pohutakawa* is a coast variety of a tree used for ship-building. This tree is one of the best known in New Zealand; large branches of it, bearing beautiful brush-like red flowers, are everywhere cut at Christmas for the purpose of decorating houses and churches. It affects rocky cliffs, its leaves are large and thick, of a greenish-blue colour on the outside, and the inside perfectly white. The trunk is gnarled and twisted in every direction. The inland variety of this tree is called the "rata," and there is a curious growth clinging to the rata, which has been the cause of much speculation among scientific men. It has not yet been decided whether it is deposited as a seed in the forks of high trees, or whether it creeps up from the ground like the ivy. It is found as a mere thread on the trunk, and thickens and sends out side shoots, and intertwines, as the ivy intertwines the oak. In time, the large tree perishes, and the frail slender growth stands alone with its arms outstretched, embracing the circular space where its supporter formerly stood, and the stems

that have grown around and about the same supporting tree will unite and form one hollow rata tree, with bark inside and out. Among the other better-known New Zealand trees may be mentioned the *Kawaka*, *Matai*, *Tanekaha*, *Rawiai*, *Manoas*, *Kowhai*, *Miro*, *Hinau*, *Titoki*, *Horopito*, *Manuka*, *Pahautea*, and *Tawai*. The number of saw-mills in the colony is steadily increasing, and it is estimated that there are 250 at present in operation, while in 1879 there were only 204; and at that time Mr. Levy, in a report to the New Zealand Government, estimated the yearly supply from each of these mills at 1,000,000 superficial feet, or about 200,000,000 superficial feet as the total annual product. It appears, from the statistical returns of the New Zealand trade, that the value of timber exported in 1881 amounted to £77,000, against £53,600 in 1880.

BRITISH ASSOCIATION.

The arrangements for the fifty-third meeting of the British Association to be held at Southampton, are as follows:—

The first meeting of the General Committee will be held on Wednesday, September 19, at 1 p.m., for the election of the President and sectional officers, and the despatch of business usually brought before that body. The General Committee will meet again on Monday, September 24, at 3 p.m, for the purpose of appointing officers for 1884, and of deciding on the place of meeting in 1885. The concluding meeting of this committee will he held on Wednesday, September 26, at 1 p.m., when the report of the Committee of Recommendations will be received.

The first General Meeting will be held on Wednesday, September 19, at 8 p.m. precisely, when Sir William Siemens, D.C.L., F.R.S., will resign the chair, and Professor Cayley, M.A., LL.D., F.R.S., President Elect, will assume the presidency, and deliver an address. On Thursday evening, Sept. 20, at 8 p.m., there will be a soirée; on Friday evening, Sept. 21, at 8.30 p.m., a "Discourse on Recent Researches on the Distance of the Sun," by Professor R. S. Ball, LL.D., F.R.S., Astronomer Royal for Ireland; on Monday evening, September 24, at 8.30 p.m., a "Discourse on Galvani and Animal Electricity," by Professor J. G. McKendrick, M.D., LL.D.; on Tuesday evening, September 25th, at 8 p.m., a soirée; and on Wednesday, September 26, the concluding General Meeting will be held at 2.30 p.m.

The following is a list of the sectional officers:—

A.—*Mathematical and Physical Science.*—President, Professor Henrici, Ph.D., F.R.S.—Secretaries, W. M. Hicks, M.A.; Professor O. J. Lodge, D.Sc.; D. McAlister, M.A., M.B., D.Sc. (Recorder); Professor Rowe, M.A., B.Sc.

B.—*Chemical Science.*—President, J. H. Gladstone, Ph.D., F.R.S.—Secretaries, Professor P. Phillips Bedson, D.Sc., F.C.S. (Recorder); H. B. Dixon, M.A., F.C.S.; H. Foster Morley, M.A., B.Sc., F.C.S.

C. — *Geology.* — President, Professor W. C. Williamson, F.R.S.—Secretaries, R. Betley, F.G.S.; C. E. De Rance, F.G.S.; W. Topley, F.G.S. (Recorder); W. Whitaker, B.A., F.G.S.

D.—*Biology.*—President, Prof. E. Ray Lankester, M A., F.R.S., F.L.S.—Secretaries, G. J. Haslam, M.D.; W. Heape; Professor A. M. Marshall, M.A., M.D., D.Sc.; Howard Saunders, F.L.S., F.Z.S. (Recorder); G. A. Woods. *Department of Anthropology.* — W. Pengelly, F.R.S., F.G.S. (Vice-President), will preside.—Secretaries, G. W. Bloxam, M.A., F.L.S. (Recorder); Walter Hurst.

E.—*Geography.*—President, Lieut.-Col. H. H. Godwin-Austen, F.R.S., F.G.S., F.R.G.S.—Secretaries, John Coles, F.R.A.S., F.R.G.S.; E. G. Ravenstein, F.R.G.S.; E. C. Rye, F.Z.S. (Recorder).

F.—*Economic Science and Statistics.*—President.—R. H. Inglis Palgrave, F.R.S., F.G.S., F.R.G.S.—Secretaries, Professor H. S. Foxwell, M.A., F.S.S.; J. N. Keynes, M.A., B.Sc.; Constantine Molloy (Recorder).

G. — *Mechanical Science.* — President, James Brunlees, F.R.S.E., F.G.S., Pres. I.C.E.—Secretaries, A. T. Atchison, M.A., C.E.; Edward Rigg, M.A.; H. Trueman Wood, B.A. (Recorder).

General Notes.

GOVERNMENT PATENT BILL.—The following statement appeared in the *Times* of the 10th inst.:—"Owing to representations which have been made to the Government, it is understood that an earnest endeavour will be made to deal with the Patents Bill during the present Session."

EXHIBITION OF PUMPING APPARATUS AT CAGLIARI.—An international competition of machines and apparatus for pumping water will be held at Cagliari, Sardinia, between 20th May and 10th June next. The limit of time for sending in applications for admission is the 15th inst. Copies of the programme, which have been sent to the Society of Arts from the Foreign-office, through the Science and Art Department, can be obtained on application to the Secretary.

LOUISVILLE EXHIBITION.—An Exhibition, to be called the "Southern Exposition," will be opened at Louisville, Kentucky, on the 1st of August next, and will continue open for 100 days. The object of the Exhibition is to bring together exhibits of the products, the industries, and the arts of the various sections of the country. A recent Act of Congress authorises the admission to United States ports of

all foreign exhibits for the "Southern Exposition," free of duty. The diplomatic and consular agents in this country, of the United States, have been directed to give additional information respecting the Exhibition, and these authorities will be furnished with the necessary circulars for issue to intending exhibitors.

NEW EXPLOSIVE.—Herr Köppel has devised a new explosive substance, which he expects to be less costly than any other, to give out no injurious fumes, and not to be liable to explosion by shock or friction. The following is the composition of two kinds, No. 1 being suitable for hard rocks, such as basalt, and No. 2 for softer, such as sandstone:—

	No. 1.	No. 2.
Saltpetre	35	42
Soda	19	22
Sulphur	11	12·50
Sawdust	9·50	10
Chlorate of Potash	9·50	—
Charcoal	6	7
Sulphate of Soda	4·25	5
Prussiate of Potash	2·25	—
Refined Sugar	2·25	—
Picric Acid	1·25	1·50
	100	100

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

MAY 23.—"Technical Instruction in Elementary and Intermediate Schools." By PHILIP MAGNUS, B.Sc., B.A. The Hon. E. LYULPH STANLEY, M.P., will preside.

MAY 30.—"The Relative Claims of Etching and Engraving to Rank as Fine Arts." By F. SEYMOUR HADEN, F.R.C.S. Sir RUTHERFORD ALCOCK, K.C.B., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at Eight o'clock:—

MAY 29.—"Queensland: its Progress and Resources." By ARTHUR J. STANESBY.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings at Eight o'clock:—

MAY 24.—"The Development of Electric Lighting." By J. E. H. GORDON, B.A.

INDIAN SECTION.

Friday evenings at Eight o'clock:—

MAY 25.—"Some Notes on the Domestic Architecture of India." By C. PURDON CLARKE. Sir PHILIP CUNLIFFE-OWEN, K.C.M.G., C.B., C.I.E., will preside.

CANTOR LECTURES.

Monday evenings at Eight o'clock:—

The Fifth Course, on "Secondary Batteries." By OLIVER J. LODGE, M.A., D.Sc.

MAY 21, 28.

MEETINGS FOR THE ENSUING WEEK.

TUESDAY, MAY 15...Royal Institution, Albemarle-street, W., 3 p.m. Professor McKendrick, "Physiological Discovery." (Lecture VII.)

Science Society, King's College, Strand, W.C., 8 p.m. Mr. J. W. Groves, "Physiogical Botany."

WEDNESDAY, MAY 16...Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. G. M. Whipple, "Composite Portraiture adapted to the Reduction of Meteorological and other Similar Observations." 2. Mr. H. Sowerby Wallis, "Note on Atmospheric Pressure during the Fall of Rain." 3. Surgeon-Major C. T. Peters, "Meteorological Observations at Zanzibar, East Coast of Africa, during 1880-81." 4. Capt. G. H. Inskip, "Diurnal Rainfall at Bangkok, Siam." 5. Mr. Arthur W. Waters, "New Method of Reading a Thermometer and a Hygrometer at a distance by means of Electricity." 6. Mr. William F. Stanley, "An Integrating Anemometer." 7. Mr. David W. Barker, "Observations on the Force of the Wind at Sea."

Pharmaceutical, 17, Bloomsbury-square, W.C., 11 a.m. Annual Meeting.

Archæological Association, 32, Sackville-street, W., 8 p.m. Mr. W. Henderson, "The Church of St. Mary, Ashford Carbonel, with reference to its Early History and the Recent Discoveries." 2. Mr. J. B. Davidson, "The Anglo-Saxon Charters of Exeter Cathedral."

THURSDAY, MAY 17...Chemical, Burlington-house, W., 8 p.m. Captain W. Abney, "Photographic Action studied Spectroscopically."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "Count Rumford." (Lecture III.)

FRIDAY, MAY 18...Royal United Service Institute, Whitehall-yard, 3 p.m. Col. George S. Walker, "The Musketry Training of the Militia."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. Professor Turner, "Domestic Industry in the Villages of Russia."

Philological, University College, W.C., 8 p.m. Annual Meeting.

SATURDAY, MAY 19... Royal Institution, Albemarle-street, W., 3 p.m. Prof. Turner, "Historical Sketches of Russian Social Life." (Lecture I.) "The Russian Peasant."

CORRECTION.—Page 643, col. 1. The last four lines of Mr. Reckenzaun's remarks in the discussion on Professor Forbes's paper last week, should read:—"There was now a boat on the Thames which contained a power of 4 horses for 7 hours, and, in the accumulators thereof, each pound of lead practically gave out 45,000 foot-pounds."

Journal of the Society of Arts.

No. 1,591. Vol. XXXII.

FRIDAY, MAY 18, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PREVENTION OF FIRES.

A public meeting will be held on Thursday, May 31, at 3 p.m., to consider the question of the prevention of fires in theatres. The report of the committee of the Society on that subject will be presented for discussion. Sir William Siemens, F.R.S., Chairman of Council, will preside.

Persons not members of the Society wishing to attend should apply to the Secretary for tickets.

CONVERSAZIONE.

The Society's Annual Conversazione will be held this year in the Buildings of the International Fisheries Exhibition. His Royal Highness the Prince of Wales, President of the Society, has intimated his intention to be present.

The precise date will be hereafter announced, and cards of invitation will be issued to the members of the Society in due course. Each member will, as usual, receive a card for himself and a lady.

LABELS ON PLANTS.

The latest date for receiving specimen labels in competition for the two Prizes of Five Guineas each, offered by the Council of the Society of Arts, will be Friday, 1st of June. The prize placed at the disposal of the Council by Mr. G. F. Wilson, F.R.S., is for a wooden Plant Label saturated with paraffin, or some other preparation which would preserve the label, and would be likely to keep the writing upon it legible, either with or without the aid of paint, for five years. The prize placed at the disposal of the Council by Mr. E. G. Loder is for the best permanent Border Label suitable for private gardens, the cost of which should not exceed £4 per thousand. Further particulars can be obtained on application to the Secretary of the Society.

Proceedings of the Society.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, April 26; Sir H. Hussey Vivian, Bart., M.P., in the chair.

The paper read was on—

A NEW PROCESS FOR THE SEPARATION AND RECOVERY OF THE VOLATILE CONSTITUENTS OF COAL.

By T. B. Lightfoot, M.Inst.C.E.

In bringing the following paper before the members of the Society of Arts, my object shall be, first, to point out briefly the necessity that exists for some simple and inexpensive method of recovering the volatile products now almost universally lost in the coking of coal; then, to describe the nature of the process recently invented by Mr. John Jameson, of Newcastle-on-Tyne, and the form of apparatus employed; and, finally, to give some particulars respecting the utilisation of the recovered products, and some considerations as to the possible application of the system.

It will be premised that all here are acquainted with the general facts that coal consists of a solid or carbonaceous component, and a gaseous or chiefly hydrogenous one, and that the process of coking is undergone for the purpose of driving off the gaseous portion, and leaving behind an almost pure solid carbon; also, that the hydrogen, in being driven off, carries with it some carbon in combination; that part of the hydrogen, by combining with the nitrogen of the fuel, forms ammonia; and that some of the hydrocarbons, as well as ammonia, are, to a great extent, condensable at ordinary temperatures, and form most valuable, and much sought for, articles of commerce.

Seeing then that this is the case, it surely must be a matter for surprise as well as regret that, at the present time, nearly the whole coke manufacture is carried on under

such circumstances as to prevent the utilisation of the volatile products in any way whatever; moreover, that these valuable articles of commerce are blackening and defacing the surface of the country. In some cases, it is true, the fumes have been collected, and passed under a boiler for generating steam, the products of combustion escaping from a high chimney; and, recently, close distillation has been successfully carried out in the ovens of Mons. Carvés; but I am certainly within the mark when I say that the gaseous products of nearly the whole of the 20,000,000 tons of coal annually coked in this country are absolutely wasted, and set free to injure vegetation. A fair idea of the meaning of such a statement may be gathered by considering the loss from this cause actually taking place in one of our greatest industries, that of pig iron. From published returns, it appears that last year there were 575 furnaces in blast in the United Kingdom, producing 8,450,000 tons of pig iron. In the majority of these furnaces the fuel is coke; but in a considerable number raw coal is still used, and of these, in only two cases, the volatile products are condensed, and recovered by a process introduced by Mr. Ferrie, though I believe the system is now being extended to fourteen other furnaces. With this exception, and neglecting the few ovens on the Carvés and on the Jameson systems at present in operation, we may take it that the condensable volatile products of all coal used in the manufacture of pig iron are entirely lost, while, in those cases where the coal has been previously coked, much of the gas is wasted likewise. Deducting, therefore, the 36,500 tons made in the two Ferrie furnaces from the total production, and taking an average of 34 cwts. of coal per ton of pig iron, we find that for this one industry alone as much as 14,302,000 tons of coal are being thus wastefully dealt with, representing, for oil and ammonia, at present prices, a loss of some £2,300,000 a year, or about 5s. 6d. per ton of pig iron produced.

From this brief consideration, I think it will be at once conceded that a real necessity exists, for a process in which the constituents of the coal will be economically separated and collected, so as to be used in the most beneficial manner. But, it may be asked, if the want is so great, has such a process not existed for some time, and are there not very good practical reasons to prevent its adoption, either on the score of deterioration in the quality of coke produced, or from some other cause? To this it may be answered that, during the last ten years, patents have been taken out for apparatus to accomplish the object in view; but in this country, at any rate, none of them have had extended application. It seems as if coke manufacturers were only now awakening to the fact of their want of economy, possibly because, in recent years, prices have been so low, and competition so keen, that profits have been cut down to the smallest possible fraction, if, indeed, in some cases they have not altogether disappeared. Another consideration of obvious importance, is that no process involving the entire rebuilding of the coking ovens, or even their alteration to any great extent, was likely to obtain speedy adoption, for all manufacturers are naturally averse to a wholesale replacement of their plant, which means a large increase in capital invested, and upon which interest must be paid.

Looking at the various processes patented for the recovery of the volatile products, prior to the working out of Mr. Jameson's plan, it may be stated that they all involved the use of close ovens, and were of two distinct characters, viz., those in which distillation was to be carried on in an oven or retort, externally heated by the gas after being deprived of its more easily condensible constituents, and those in which the gas was to be used inside the oven itself over the charge, for giving the heat required in coking. Of these, so far as I am aware, externally heated ovens have alone been successful in practice.

Now, without entering into any detailed criticism of this system, which doubtless gives good results, I must just mention what appear to me to be its principal objections, in order that I may the more easily show in what respects Mr. Jameson's plan is, in my opinion to be preferred for the treatment of large quantities of coal.

A great objection to externally fired ovens is their excessive first cost, and, on account of their special form, it is quite impossible to alter existing plant for the carrying on of the process; then again, there is a considerable waste of heat, owing to the high temperature which must be maintained within the flues, a consideration which will, perhaps, be best appreciated by remembering that, in ordinary gas works, with externally heated retorts, about 26 per cent. of the total coke produced is consumed for heating purposes; and finally,

there is the cost of repairs, which cannot fail to be greater than usual, on account of the number of flues, all exposed to intense heat, and the practical difficulty of having to quench the coke after withdrawal, a proceeding which, as is well known, is apt to leave an excessive amount of water in it when sent out to the purchaser. Added to this, the beehive oven is that which is generally acknowledged to be not only the easiest built and kept in order, but also to produce the highest quality of coke. At the same time, it cannot but be admitted that, in certain cases, where no use could be made of the gas, it might be more economical to dispose of it for heating the charge rather than let it go to waste ; but this, I need scarcely point out, should be a very exceptional circumstance, and one which could hardly exist at all in this country, if the value of gas, as a heating agent, was more fully recognised.

In applying Mr. Jameson's process, it is not necessary to rebuild the ovens, the form being retained precisely as in use at the present time, and the extraction of the gases accomplished either by inserting in the floor a couple of perforated iron pipes connected with an exhauster, or, preferably, by forming the bottom with perforations in the fire-clay quarls themselves, and applying a slight suction through all the openings. The process is, therefore, immediately applicable to the whole of the ovens treating the 20,000,000 tons of coal annually coked, and if this were done, there would be obtained from this source alone ammonia corresponding to at least 90,000 tons of sulphate, at present worth more than £1,250,000. The oil would also be worth some £2,000,000, and the gas, at even 3d. a thousand cubic feet, would come to £2,500,000, making in all the enormous total of £5,750,000 as the commercial value of products now being entirely wasted in the coking process.

The diagrams show an ordinary beehive oven adapted to the recovery process. The only alteration is in the floor, which, with the exception of the solid margin, consists of perforated fire-clay quarls laid on a bed in which are formed the passages, these passages communicating with the main pipe, by means of the branch, in which is an ordinary screw-down valve or water-lute connection for shutting off the oven when not in operation. The object of the arrangement is to draw off the gases at the bottom by producing a slight suction in the main pipe. It is, therefore, important to have a secure and tight foundation, so as to avoid drawing in air and vapour from the surrounding ground, and for this end it is well to have a double layer of bricks set in hard pitch, at such a distance down as not to be exposed to undue heat, as well as to have a good damp-proof course, such as is laid in the foundations of a dwelling-house.

A bench of twenty ovens with recovery plant is also shown. The main pipe, with which each oven is connected, extends along the entire length underground, with a fall towards the condenser, which, in its simplest form, is a range of cast-iron pipes exposed to the cooling action of the atmosphere, or surrounded by water in cases where it can be obtained without much expense. The condenser discharges through a lute into the separator, a pipe being carried on to the exhauster or fan, driven by the engine, the speed of which can be regulated to obtain the proper suction required at the different periods of the operation. From the exhauster, the gases, deprived of their condensable constituents, may be taken where desired, but the diagram shows them discharged under the boiler for generating the steam required by the engine. The liquors, being delivered into the separator, arrange themselves according to their specific gravities, and a rough division is therefore made by running off the crude oil into one tank, and the ammoniacal liquor into another.

The cost of altering existing ovens to Mr. Jameson's plan is stated to be from £15 to £20 each, this sum including all requisite connections and condensing-pipes, which are of the simplest possible description. Bearing this in mind, as well as the fact that the increased cost of working the new system does not amount to one penny per ton of coal, it will be seen that, not only is there no impediment, on the score of outlay, to prevent the immediate adoption of the process, but that the sale of recovered products is likely to become an exceedingly profitable undertaking.

The action is as follows:—The ovens are charged from the top, and in the usual manner ignited. A suction equal to about one inch of water is then applied by the exhauster through the pipes to the bottom of the charge, and the products of distillation continuously drawn off, the charge, to all appearance, burning in the usual way. During the process, the effect is produced of a gradually increasing heat, commencing at the top, and passing downwards slowly to the temperature of intense incandescence in every part of the oven. In the old system, the gases and vapours evolved

at a comparatively low temperature percolate through the more highly heated upper layers, and there suffer decomposition; but in Mr. Jameson's process, while the operation of coking is, to all intents, going on in the ordinary way, the gases and vapours are withdrawn as they form, and any decomposition effectually prevented. In point of fact, from the moment of formation they are actually cooled, heat being abstracted by the unchanged portion of the charge towards the bottom of the oven, this being shown by the circumstance that, when taking away about 200 cubic feet of gas per hour per ton of coal, and continuing this withdrawal for about sixty hours, the temperature of the pipe, on emerging from the ground, does not average more than 180° Fahr.

Owing to the supply of air being admitted at the top, the upper surface of the charge suffers combustion, so supplying most of the heat requisite for coking. The advantage of thus utilising a portion of the highly heated coal charge itself, is twofold. In the first place, by using carbon as the heating agent, a thermal intensity is gained, which cannot possibly be reached by the combustion of the gas, while, in the second place, the average quality of the coke is improved. All those acquainted with the making of coke in the ordinary way will be aware that the top layer is extremely porous and inferior, from being formed at a low heat, in a comparatively cool freshly charged oven. It is this upper surface that is burnt off in the Jameson process, and so an objectionable element is got rid of.

From what has been said, it will be seen that the production of coke in the Jameson ovens must necessarily be somewhat less than with close distillation. This difference amounts to not more than 2 cwts. of coke per ton of coal treated, in favour of externally heated ovens. On the other hand, however, it is claimed for Jameson's process that the average quality of coke is better, and of course, as a set off against the lessened production, there is the saving in valuable gas, which may be used for heating, for giving power, or for lighting in connection with such burners as the Lewis or Clamond, which depend for their illuminating power on the incandescence of platinum or some other incombustible material, instead of on the fine particles of carbon deposited in the flame itself. There are also advantages for the Jameson system on account of lessened first cost, and its adaptability to ovens now in existence. These are most important factors, and though it is impossible to place any average money value upon them, they must not be overlooked when considering the merits of the new process.

The volatile products are the products of distillation of coal at a low temperature, and are to be regarded as the vapours of various hydrocarbons of the paraffin series and of ammonia, saturating an atmosphere consisting chiefly of hydrogen, nitrogen, and carbonic oxide. Up to the present time, with the imperfect condensing apparatus employed, the data indicate that an average yield of about eight gallons of crude oil, and ammonia equal to a production of ten pounds of sulphate, may be expected per ton of coal; but with improved condensing arrangements, there is no doubt that a considerable quantity of vapours, especially ammonia, now lost, will be recovered. The oil is a crude paraffin of specific gravity, about ·96, and contains a considerable quantity of solid paraffin of high melting point; but both quality and quantity vary so much with the kind of coal under treatment, that on this point it is impossible to give more than a general idea. The following Table gives a few of the results obtained per ton of coal treated:—

Kind of Coal.	Gals. of Crude Oil.	Ammonia estimated in Pounds of Sulphate.
Shiremoor	13	9·87
Brancepeth Cannel....	12·2	6·00
Longhirst, small	9·28	17·78

The following may be taken as an average analysis of the crude oil:—

	Per cent.
Lubricating oil	39·5
Burning oil	37·7
Paraffin scale	13·5
Tar and loss.....	9·3
	100·0

In reference to the question of condensation, I should like to draw attention to a process which, though successfully tried on a practical scale some years ago, has, to my mind, not yet received the attention it deserves. I refer to the compression of the gas and vapour, and the subsequent cooling of them when under compression; first, by an external application of water, and then of the gas itself, cooled much below its original temperature by expansion behind a piston after its passage through the condenser under compression. This method formed the subject of an interest-

ing paper, read before the Chemical Society of London, in 1875, by Mr. J. J. Coleman. It will be easily understood by remembering that, under constant temperature, an increase in pressure decreases the capacity of a given weight of gas for holding vapour in solution. In a saturated mixture, therefore, a vapour will be condensed and deposited, either by an increase in pressure, or a reduction in temperature. The process referred to accomplishes both, and by its means the volatile products, after being treated by all ordinary condensing apparatus, may be made to yield liquids of low specific gravities and boiling points which might be valuable as local anæsthetics, or as the refrigerating media in ice-making machinery.

Reference should be made to the method of fractioning, for the purpose of getting an automatic separation of the products according to the temperatures of liquefaction, without future distillation. This is now being carried on at Felling, by Messrs. H. L. Pattinson and Co., who, by placing discharge lutes at five different points in the condensing pipes, are obtaining liquors of specific gravities from ·945 to 1·015. Another mode of separation is one by which a series of five gas mains is provided, and connections made, so that the gas may be passed into each main in turn, for the purpose of securing some difference in the quality as well as a fractional separation of the bye-products. With this arrangement, the discharge of gas is, every twelve hours, or at other convenient interval, passed into a different pipe for separate condensation, all the freshly charged ovens delivering into the first pipe, and so on through the series, according to the time which has elapsed since the commencement of distillation. Suction being applied through the last main during quenching, the pipes would be cleared of coherent dust and oil, and a considerable quantity of carbonic oxide and hydrogen obtained, as well as ammonia, which would otherwise have been wasted in the quenching water.

Mr. Jameson's process is in operation at the Felling works of Messrs. Hugh L. Pattinson and Co., and at the Page Bank Colliery of Messrs. Bell Bros., Limited, and is at the same time being introduced in the works of the Weardale Iron Co., and at some collieries in Northumberland. A number of experiments have been carried out by Mr. Lowthian Bell, F.R.S., to test the value of the system, both in regard to the yield and quality of coke, and the value of the recovered products, and further investigations are now in progress, as well as extension of the plant, so as to obtain sufficient coke for the entire working of a blast furnace.

An interesting application of an analogous patent, recently taken out by Mr. H. L. Armour, and the property of the Jameson Coke Company, Limited, has just been made in the case of a pit heap, at Seaton Burn Colliery, in Northumberland. A pit heap is a deposit for quantities of small coal and dust, for which, as a rule, no market can be found, as well as for shale and iron pyrites met with in working the coal. These heaps are generally burning, and, in very many instances, give off so much smoke and dirt as to become a terrible nuisance to the neighbourhood. This was the case at Seaton Burn; but by simply covering the heap with sand, and sinking a number of iron pipes connected to a main, in which a constant suction is maintained, all offence has been removed, and a stream of gas, yielding both oil and ammonia, is obtained. In this manner a worse than valueless property has been converted into a profitable one, and, as the system is now being extended to large heaps at Kelvinside, near Glasgow, it is to be hoped that before long an end will be put to one of the greatest nuisances in colliery districts.

Though many of the members of this Society are far better acquainted with the commercial value of the recovered products than I am, I must now ask you to let me say a few words as to the probability of such large quantities of oil, ammonia, and gas being profitably employed in the various industries which do exist, and are likely to exist in this and other manufacturing countries.

At the present time, we depend for our supply of petroleum or mineral oil on two principal sources—the natural springs of Canada and the United States, and the distillation of bituminous shale, which has been developed in Scotland into an immense industry chiefly by the instrumentality of the late Mr. James Young. According to statistics published in *The Oil Trade Review*, it appears, that, in 1882, we imported from America 41,500,000 gallons of petroleum oil, and close on 6,000,000 gallons of petroleum spirit or benzoline. Towards the end of the year, the price of the oil, which for the first nine months had ruled about 5½d. a gallon, received a sudden rise, owing to reports reaching this country of the failure of the supply, and went up to as much as 7½d. and

7¾d. a gallon. Without, however, attaching too much importance to the apparently failing supply of American oils in estimating the value of the English product, there can be no doubt that, at the present time, the average daily supply is nearer the daily consumption than it has been for the last five years, and it is in the highest degree probable that a permanent rise in price will before long be made, unless supplies come in from other sources. Some interesting particulars respecting the petroleum supply were given in the Society's *Journal* for September 1st, 1882. With regard to the distillation of shale, few persons are aware of the immense magnitude of the works engaged in this industry. Altogether, in Scotland, there are about seventy oil works, at about forty of which crude oil alone is made; and I find, from particulars supplied by Mr. Thos. Scott, of Edinburgh, that there are two companies, each distilling 700 tons of shale per day, while two others each distil 400 tons, and five others each 200 tons. Two firms each make twelve tons of paraffin candles per day. When it is remembered that something like thirty gallons of crude oil, and ammonia equal to seventeen pounds of sulphate are obtained per ton of shale, the importance of the industry, and the great demand for the products, will be apparent. Shale oil works also exist in Wales and Cheshire, but are now almost kept going in refining crude oil from Scotland on account of their supply of shale being exhausted. The great demand for crude oil is for the manufacture of illuminating and lubricating oils and solid paraffin, while from some are obtained the aniline dyes and other valuable products.

Illuminating gas of a very high quality is also made from the oil, and recently this application has received considerable development by Messrs. Rogers Brothers, of Watford, who have succeeded in producing an oil gas, of great brilliancy and purity, which promises to compete commercially with gas made from coal in the ordinary way. The "Koh-i-noor" gas, as it is called, is made by injecting a continuous stream of oil into the end of a small iron retort, by means of a jet of highly superheated steam. After flowing to the end of this retort, the stream returns through an annular space formed by a second tube placed outside the first, and externally heated by a coke fire. The gas is then conducted to a small washer, and requires no purification, as it contains neither sulphuretted hydrogen, tar, nor ammonia. Its cost is stated to be about two-thirds that of coal gas for equal light, 300 cubic feet of 70-candle gas being produced from two gallons of oil; and a great advantage of the process is, that any existing gas-works can be converted at a comparatively trifling cost, while, on account of the high illuminating power, a main of given size can transmit more than four times the amount of light that it does at present.

With regard to ammonia, it will be known to most of you that there has been rapidly springing up of late years a new process for the manufacture of soda, perfected by M. Solvay, of Brussels, and known as the ammonia process. In a recent paper, read before the Society of Chemical Industry of London by Mr. Walter Weldon, F.R.S., it was pointed out that, though the commercial success of M. Solvay's process only dates from 1866, yet already 163,000 tons a year, or 23 per cent. of the total soda production of the world, is made by it, and that at the present time seven large works, capable of making about 7,000 tons of ammonia soda a year, are being built, while several others are in contemplation. In point of fact, the Leblanc process threatens to become extinct, unless some means are discovered for greatly lessening the cost of production. Now, notwithstanding all that can be done, the annual loss of ammonium sulphate in making the 163,000 tons of soda amounts to no less than 9,000 tons, so that, in this trade alone, it is evident that the demand for ammonia is likely to be very great and increasing. Curiously enough, in the same paper, Mr. Weldon not only pointed out that the Jameson process would be likely to supply the demand for ammonia created by the extension of M. Solvay's system, but that by its means it might be possible to so lower the cost of production of Leblanc soda as to enable it to successfully compete with that made with ammonia. In the Leblanc system, fuel, which at the present time is coal, amounts to as much as 350 per cent. on the weight of soda produced, while M. Solvay uses but 150 per cent. It was, therefore, suggested that the Leblanc soda makers should entirely cease to use raw coal as a fuel, and should convert all their coal, except that used for mixing in the black ash process, into coke, collecting for sale the oil and ammonia, and utilising the gas for heating purposes. If this could be done, and duff, or very small coal, used for coking, the soda maker would virtually obtain his fuel for

nothing, as the value of the recovered products would cover the original cost of the coal, and, in some cases, the expense of coking as well.

Turning to agriculture, it is evident that now that the guano deposits are becoming exhausted and poor in quality, the demand for artificially produced manures will increase year by year. In a letter from Dr. Angus Smith, read at a meeting of this Society on the 26th of January, 1881, it was stated in effect that the ammonia from 1,000,000 tons of coal, if used in manure as ammonium sulphate, would add about £533,000 worth of foods to the produce of the land; while, if the ammonia from all the raw coal now burnt in this country was utilised in agriculture, we should add £50,000,000 worth of bread stuffs, and might begin to export. Without venturing to say that this could be realised, I think it will be agreed that an increased supply of ammonia must be of immense importance to the agricultural prospects of this country.

The great value of ammonia renders it imperative that the greatest possible production should be obtained. It is usual to say that coal contains so much ammonia, but it is of course well known among chemists that such a statement is untrue, only the elements for its production being contained. These are nitrogen and hydrogen, and as the latter gas is always present in much greater quantity than is needed for the conversion of all the nitrogen into ammonia, it is the amount of nitrogen present that should determine the ammonia producing power of any coal. Unfortunately, only a small proportion of the nitrogen is thus made use of, about 40 per cent. remaining in the coke unchanged, while a large per-centage is driven off with the gas in its elementary condition, and only from 14 to 20 per cent. combines with hydrogen to form ammonia. There is, therefore, much scope for ingenuity in finding some means for further utilising the supply of nitrogen, and it is to be hoped that the researches of Professor W. Forster, M.A., some of which were embodied in a paper read before the Chemical Society of London, on the 21st of last December, will throw greater light on this important subject.

The composition of the gas collected from the Jameson ovens, after its passage through the condenser, varies according to the coal under treatment, and the length of time the charge has been burning. An approximate average is given in the following table :—

CO_2	3·5
CO	27·5
H	29·3
O	1·1
N	38·6
	100·0

And from this it will be seen that, compared with London coal gas of average quality, its calorific power is about one-third. As a heating agent, therefore, assuming its cost to be 6d. a thousand cubic feet, the price for a given effect will be 1s. 6d., as against, say, 3s. for ordinary coal gas.

It cannot be overlooked that there is a very wide-spread feeling that the time is not far distant when the existing method of obtaining motive power by the generation of steam will be superseded by a more economical process, in which heat energy will be directly converted into mechanical work, without the intervention of a fluid such as steam, which, in the best compound engines, only permits a utilisation of about one-tenth of the energy developed in the furnace. Expression was given to this by Sir Frederick Bramwell, F.R.S., at a meeting of the British Association in 1880, when he stated that if the Mechanical Section of that association should meet fifty years hence, he thought members would not speak of the steam-engine except as a curiosity to be found in museums. At the present time, gas-engines of comparatively small power, constructed by Crossley Brothers, Limited, and using Dowson's gas, are actually working with a fuel expenditure of 1·4 lbs. per indicated horse-power per hour, a performance rather better than that of the best steam-engines; and though there are, doubtless, many practical difficulties to be overcome, I certainly look forward to the time when our present wasteful method of using coal, for obtaining motive power, will give way to a system more in accordance with the spirit of the age.

With these considerations in view, I think it is certain that the gas recovered in the coking process, instead of being consumed under a boiler, will be utilised in gas-engines, for the production of all power required in the neighbourhood of the ovens, for the working of the colliery and other machinery, and in adjacent factories; while there is also the probability of its use for the generation of power in the form of electric energy, to be transmitted for conversion into light or mechanical work. In this latter case, I of course refer to the establishment of large generating centres in the im-

mediate neighbourhood where the gas is produced, and in this connection the recent experiments of Deprez and Herz are especially interesting, and may possibly give the proposed application still greater importance.

It now only remains for me to ask your attention for a short time, while I make an appeal in favour of the substitution of gas and coke for heating purposes, both in manufactories and dwelling-houses, where raw coal is now employed. Look at it how we may, the use of raw fuel at the present time is only to be regarded as a relic of former ignorance, handed down from a time when the chemical compositions of coal and its products were unknown, when there was no use for ammonia, or for what we now call the bye-products, and when economy was the last thing thought of provided the desired result was obtained. Now, however, all this is changed. We have ascertained the composition of coal and its products with the greatest accuracy, and we know, as an absolute fact, that in burning the condensable volatile constituents, we are consuming materials which, if applied in the arts and manufactures, have an intrinsic value many times above what they bear as heating agents. Besides which, we are producing smoke and dirt, fouling the atmosphere, and encouraging certain forms of disease, and in domestic fire-places, according to a favourable estimate, are sending 60 per cent. of the heat up our chimneys. And what is the set-off against all this? Nothing at all, as far as I can see, in regard to manufactories, where it is admitted gas would be a cheaper, more convenient, more easily regulated, and more cleanly fuel; while, in domestic fire-places, the luxury of having a blazing fire which can be poked, is the only reason I have heard alleged in favour of the retention of the present system, which involves more expense and more labour than if gaseous fuel or coke had to be dealt with. I am not now alluding to the use of ordinary illuminating gas, which Sir Wm. Siemens has shown can be economically and advantageously applied as fuel in combination with coke; but I refer to a gas made specially with a view to heating purposes, such as the gas obtained in the Jameson process, and which would be supplied at a cost of not more than 6d. a 1,000 cubic feet. Such a gas would be available for all manufacturing purposes, and by using it with some regenerative system, the highest economy would be attained. It would also be delivered to our houses, and consumed for cooking and warming, either with or without coke, while it would also be suitable for driving gas-motors, if, indeed, electricity, generated by engines worked with the gas near its point of production, had not previously stepped in for driving our domestic machinery. It is, however, difficult to see how electricity could compete with gas as an economical motor, unless it was on the score of simplicity, as with gas at hand, except under special conditions, it would obviously be cheaper to use it directly in an engine than through the medium of electric energy.

An interesting paper by Mr. George E. Davis is published in the February number of the *Journal of Chemical Industry*, from which much practical information can be obtained as to the comparative values of various methods of warming rooms. The results arrived at, after many carefully conducted experiments, were that one ton of dry coke, burnt alone in a suitable stove, has the same heating effect as a ton of Lancashire coal, and is smokeless, and that twelve cubic feet of ordinary coal gas is about equal in heating effect to one pound of coal. In the following Tables are given summary of costs for coal, coke, and gas, the latter being of the usual quality supplied in Manchester and rather better than what we have in London:—

		Pence.
In fire-grate..	Coal, 40 lbs., at 8d. a cwt.....	2·86
	Coke, 50 lbs., at 7s. 6d. a ton	2·00
Gas-stoves	Fletcher's, 240 c. ft., at 3s. per 1,000	8·64
	Lux Calor, 200 c. ft., ,, ,,	7·20
Stove....	Coal, 18 lbs., at 8d. per cwt.....	1·20
	Coke, 20lbs., at 7s. 6d. a ton	·80

In a stove in use in Mr. Davis's study the cost per day is—

Coke for 13 hours, 14 lbs., at 7s. 6d. a ton	0·56
Gas for lighting, 10 c. ft., at 3s. per 1,000	0·36
Total	0·92

and the temperature of the room is raised from 45° F. to 60° F., in one hour, and easily maintained. It would, therefore, seem that, as a heating agent, coke is by far the most economical, especially when applied in a close stove. Unfortunately, however, this mode of application is one which is open to objection from several points of view. It first of all is incompatible with the generally accepted idea that the fire must be visible, and then there is the chance that, through some negligence, carbonic oxide may be permitted to escape into the room. I am, therefore, inclined to think that we should look to the heating of our dwelling-houses by the combustion of

coke, with or without gas, in an open fireplace, specially constructed to carry on the operation in an economical way, but for convenience in lighting the coke, and in regulating the temperature, as well as from the more pleasant appearance of the fire, it appears probable that the combination of coke and gas, as suggested by Sir W. Siemens, will be the method more generally adopted.

At the present time, it is estimated that about 80,000,000 tons of coal are annually consumed in the raw state in this country. Probably part of this coal is unfit for coking; but even taking 60,000,000 tons as the quantity which might be treated by the Jameson process, we have, at present prices, £17,250,000 as the annual value of the by-products now being wasted, provided the gas could be utilised in the manner previously mentioned. This is exclusive of the sum of £5,750,000, previously referred to as the value of products which might be recovered from coke ovens now in operation, which would bring the total to no less than £23,000,000 a-year. Besides this, it is possible to bring into use large quantities of duff and shale now left at the pits, from which both oil, ammonia, and gas could be extracted. The attainment of such a result is of immense importance, but it can only be accomplished along with the introduction of improved systems of obtaining motive power and heat, and surely these are matters well worthy the serious consideration of the members of this Society.

I will not now detain you further, but will conclude, in the hope that what I have had the honour to lay before you this evening has been sufficient to establish the following propositions, which I had in my mind when I commenced:—

1st. That Mr. Jameson's process meets a great industrial want that has hitherto not been met.

2nd. That it is desirable to do away with the use of raw coal as a fuel, substituting for it coke and gas, after the separation and recovery of the more volatile constituents.

DISCUSSION.

Mr. J. C. Stevenson, M.P., said he had had the advantage of seeing this process in operation at Messrs. Pattinson's works, and although he was not prepared to say that all the advantages which were anticipated would be actually realised, still it was a most interesting experiment, directed to a very desirable object. The anomaly of treating coal in its raw condition, and sending into the air its horrible products, showed a condition of things which he hoped, in future days, would be looked back upon as the backward state of chemical industry of the 19th century. There was one point which had not been noticed in the paper, and that was this: it was well known that there was about 2 per cent. of sulphur in all the coal which was burnt, but no reference had been made as to what became of it by this method of treating the coke. It would be a desirable thing if the sulphur, which at present only vitiated the air and destroyed vegetation, could be used for industrial processes. In London alone, some thousands of tons of sulphuric gas was turned into the air every week, and, therefore, if this process would help to remedy that state of matters, it would be an additional recommendation in its favour. He was interested in the Leblanc process, which had been described as likely to benefit by the improved process for utilising the products of coal; but, up to the present, they had not obtained any practical proof that that result would be attained. Still, at the same time, it was one which they must look forward to with very great interest, and if these products of coal could be recovered, a great end would be accomplished. In performing any coking operation, a large quantity of heat must be expended in burning the coke. At Pattinson's experimental ovens, the gas was only measured and turned back into the coke oven, to assist in giving the necessary high temperature which was required for the production of hard coke. A great deal of heat had to be expended on the spot to heat the coke which was produced, and the flame necessarily escaped from the top of the oven into the flue, so that, unless you could use on the spot the heat which must always accompany the working of a coke oven, you would not obtain the full benefit of the fuel. The paper opened up a most interesting field of progress, and it was to be hoped that the inventors of the process would receive a due return for their ingenuity and enterprise.

Mr. B. E. R. Newlands remarked that he had seen the apparatus in question at the Felling works in operation, and, to his mind, the apparatus had been very roughly constructed. He was told that the amount of ammonia yielded by a ton of coal varied from 2 lbs. to 13 lbs., and when the best coal was used, it sometimes only gave 60 per cent. of coke, and a very poor yield of ammonia, so that he did not think one was justified in saying that, if this process was applied to the coking of all the coal in the kingdom, the same good results would be obtained. Some of the suitable coals would, no doubt, give very good results, but if inland or ordinary north country coals were experimented upon, the results would not be so favourable. The weak point of the process arose from the fact that there were two draughts, one at the bottom and the other at the top, and it was a question which of these two draughts obtained the mastery. When at the

Felling works, he ascertained that the exhaust had the mastery, as was apparent from the fact that the gas contained 38 per cent. of nitrogen. He should be glad to learn from Mr. Jameson that there would be a saving by the use of his process in London, because, as at present advised, he thought the process was only applicable to the colliery districts and to certain coal.

Sir FREDERICK ABEL, F.R.S., said this subject was one which had engaged the attention of persons interested in the subject, and was one which had also occupied the attention of the Royal Commission appointed to inquire into the subject of noxious vapours. At one time it seemed hopeless to bring proprietors of coke ovens to see the importance to themselves, as well as to the country, of instituting experiments upon a large scale, with a view to economise fuel, and to prevent smoke and noxious gases from escaping into the air. That Mr. Jameson had done a great deal in this direction could not be doubted. If only some of the better conditions of coal were burnt with advantage, then he had still done a great deal, and it was to be hoped that the first successful efforts of Mr. Jameson would be followed by others equally successful with regard to low qualities of coal. The time could not be far distant when a large amount of slack would be converted into fuel for blast furnaces, through the agency of coke ovens, arranged on the principle which Mr. Jameson had applied with some success in this direction. With regard to the application of gaseous fuels to heating purposes, it could not be doubted that the time was not far distant when they would be able to supply houses with fuel thus made, and that there ought also to be an important advance in the method of burning of such fuel, and of applying it also, by simple means, as an illuminating agent.

Mr. H. L. ARMOUR said his connection with the patent was not a very prominent one, and, therefore, he might perhaps be excused for making few remarks with regard to it. He was attracted to the subject by a lawsuit commenced against the Tyne Main Coal Company for a nuisance arising from a spoil-heap, and a method occurred to him of dealing with this nuisance, which was somewhat analogous to the process adopted by Mr. Jameson. The process which he applied had been since patented. The method would commend itself to every one as a cheap way of dealing with a carbonaceous heap, where the volatile constituents lose so small a proportion to the bulk to be treated, that to handle the stuff in small quantities, and with specially built apparatus, would be out of the question. Wherever there were collieries there were large spoil-heaps, and some of these heaps would take fire of themselves. One of these heaps which had thus fired spontaneously was operated upon, and he had proved, by a very simple apparatus, that they could cheaply draw off the carbonaceous gas and ammonia, and get a fair heating gas from it. This was effected by covering the heap with sand, and thrusting pipes into it, and applying suction. Another set of heaps, which were not of a sufficiently volatile nature to set fire to themselves, would shortly be operated on in Glasgow. Considering that there were large refuse heaps at nearly every colliery, there was certainly a very large field for the application of this patented process.

Mr. W. R. E. COLES said Mr. Lighfoot had described a system which had been tried upon a practical scale, and he thought it was one capable of practical development; that there were imperfections in it, as had already been pointed out, there could be no doubt. The paper dealt with some points connected with the use of the gas to be obtained by the process in a somewhat slight manner; in one particular case it assumed that the gas would be used in gas-engines, but the experiment which had been made with the common type of gas-engines tended to show that the motive power, speaking broadly, was relative to the illuminating power. With regard to the use of the gas obtained for heating purposes by this process, the value was assumed to be 3d., but that was purely an arbitrary estimate. There could be no doubt that, at the present time, there was no system that could commend itself to any practical man, by which to use gaseous fuel under steam boilers. Passing away from the particular process to the very broad conclusions drawn by Mr. Lightfoot, that we should do away with the use of raw coal, he could not endorse that remark, for this reason, that every one knew that a large proportion of the coal of the United Kingdom was unsuited to treatment by the process. He had received a letter from Dr. Angus Smith, in which that gentleman, after stating his inability to be present that evening, said he endorsed the statement in the paper as to the food products which might be obtained by the use of ammonia as a fertiliser. Dr. Smith also referred to the Carvés process rather more favourably than Mr. Lightfoot had done, and with regard to the Jameson process, he stated that, having seen the furnaces in operation, he much admired them, but was somewhat disappointed in finding that the total products mentioned in the paper were not obtained. With a view of giving some idea of the margin for saving in the chief heating processes, he (Mr. Coles) had taken from the well-known work of Mr. D. K. Clark an approximate statement of the heat utilised. In blast furnaces they utilised about 42 per cent., in steam boilers of improved types from 60 per cent. to 70 per cent., in drying furnaces 45 per cent., in common puddling furnaces 4 per cent., and in Siemens's regenerative furnace 16½ per cent. From trials made with domestic heating appliances, it was found on an average that, from a large number of open grates, 43 per cent. of the heat generated was carried up the chimney, 42 per cent. was radiated into the room and absorbed by the walls, and

15 per cent. was lost by conduction and radiation externally. From stoves, these figures would be respectively 24 per cent., 54 per cent., and 22 per cent., while there was a wide difference in the heating efficiency of various open grates and close stoves, say from two to six degrees rise of temperature in the room per lb. of coal burnt in open grates, and three to eleven degrees in close stoves, and even wider discrepancy in the efficiency of boiler furnaces. Thus it was obvious there were ample scope and need for general improvement in appliances for the use of raw coal, as well as for the application of gaseous fuel.

Mr. J. JAMESON said Mr. Stevenson had correctly pointed out that there was 2 per cent. of sulphur in ordinary coal. Some samples of coke made by the process which had been described having been tested, it was found that the quantity of sulphur remaining in the coke was 0·8 per cent. There was a process for obtaining the deposited sulphur, and he hoped that there was a prospect before them of recovering about half the sulphur which came away from the coal in the form of sulphuretted hydrogen, and if successful, they might therefore expect 0·6 cwt. of sulphur per ton of coal treated, or from the spoil-heap, a still larger proportionate yield. Mr. Newlands had drawn attention to the fact that the ammonia yielded by a ton of coal varied from 2 lbs. to 13 lbs., this arose to some extent from variation in the quantity of the coal treated, but it also arose from the fact that the trials tabulated gave results of many experiments on different modes of working, sometimes with suction too great, and sometimes too little, and with very varied conditions as to condensing surface and exposure, so that an average did not correctly represent the result with proper application to the process. The figures given in the paper might, he believed, be taken as fairly correct. With regard to the draughts which had been spoken of, the draught at the top of the oven was as nothing as compared with the draught at the bottom. The 38 per cent. of nitrogen which Mr. Newlands referred to was explained partly from the imperfection of the arrangement at the oven bottom, but partly from a cause incidental to the process itself, namely, owing to the coal drawing itself together in the process of coking, and affording a small passage for the air beside the oven walls, and especially towards the end of the process. The oxygen shown on the table was due to a leakage of air into the condensing pipes, from imperfect jointing; it was impossible that oxygen could remain in air passing through the oven. With regard to the remarks made by Sir Frederick Abel, he might say that lately they had been operating upon spoil at Broomhill Colliery, in Northumberland. The waste from this pit, to the extent of 300 tons per week, have hitherto been sent by rail to Amble, there put into hoppers for conveyance to sea, and sunk; if made into a heap at the colliery, the heap would spontaneously fire, and injury would result to the neighbourhood. Lately, experiments were made with this spoil, and in result was obtained a large quantity of good burning gas, a considerable yield of oil and ammonia, and an entirely innocuous refuse. The exact yield of products has not yet been ascertained. In Dr. Angus Smith's letter, read by Mr. Coles, he expressed regret that the whole of the products of coal were not recovered; that was, unfortunately, too true, but he might express a hope that having got a considerable quantity of products, and not seeing their way to obtaining more, they ought to be thankful for what they had got. In regard to the quality of the oil produced, he believed that the yield of any coal at equal temperature was alike. In the case of the coke oven which had been described, the moment the coal was so heated as to part with the volatile constituents, the products were taken down through colder coal and taken away; whereas, in gas works, the constituents, liberated at the same heat, came in contact with the sides of an intensely heated retort, and so underwent a second decomposition, which resulted in the formation of new compounds. He believed that, by some process of treating the oils, nearly all the products obtainable in gas works might be produced. Some experiments had been tried by Mr. Norman Redmayne, of the Felling Chemical Works, by passing the vapour of these oils through a red-hot combustion tube, testing for benzol before and after, and he found that a very considerable increase in the quantity of contained benzol was thus produced. A question had been asked as to the difference between the oven described by Mr. Lightfoot and that of Mr. Aitkin, of Falkirk. He might state that the latter was a close oven, called a "blast oven," worked by a blast of air driven in at the top, and producing a slight pressure of air in the upper part of the oven, to effect the coking of the coal; and his own oven was an entirely open one, in which the coking was effected in the ordinary way. Many previous efforts had been made to recover the volatile products evolved in the coking of coal, but invariably these efforts had been directed to accomplish that by a more or less perfect closing of the oven, and he believed that the oven now under consideration was the first and only one in which the products had been recovered while the process of coking was carried on entirely in the ordinary manner.

Mr. WALTER BROWNE said that when this process was described before the Institution of Mechanical Engineers, Mr. Jameson had been taken to task for not having produced samples of coke, in order that the different qualities might be compared, and he was happy to see that, upon this occasion, there was no room for any such complaint. He thought the coke produced by Mr. Jameson's process was as good as that produced by the ordinary ovens. He had had the Siemens gas and coke fire in his own dining-room for three winters, and with satisfactory results. In this grate it was very difficult

to get a draught, but notwithstanding that, the result had been good, especially as to the absence of dirt and smell. He could not understand why this process had not made more progress, unless it was from the fact that Sir W. Siemens had neglected to take out a patent for it.

The CHAIRMAN observed that there was no question which touched Englishmen more deeply than the question of the consumption of coal. Many years ago, great anxiety was felt throughout the country, as to the condition of the coal-fields; so great was this anxiety that it was commented upon by Sir William Armstrong, and also by Mr. Gladstone, who made it a foundation for the reduction of the National Debt. He (the Chairman) felt that the fear was unfounded, and, in order that the question should be at once and for ever set at rest, in 1866, he moved for the appointment of a Commission to investigate the supplies of coal unwrought in this country. That Commission entered very laboriously into the whole question, and reported that the coal-fields were capable of supplying the wants of the nation for a very great number of years, at the present rate of consumption. How great the increase in consumption would be no one could tell, but there were two opposing forces constantly at work, one being the introduction of economy in the use of mineral fuel, and the other, the constantly increasing wants and draughts upon our stock. The process which had been described that evening was one for economising the consumption of fuel. He believed that the present system, both in domestic use and in the manufactures of the country, was an excedingly wasteful one, and, therefore, one could not but hail with the greatest satisfaction any proposition which offered a chance of success in economising fuel. The prospect held out was one of great advantage also with regard to the future agriculture of the country. If anything like the results could be obtained which had been foreshadowed, the production of ammonia would be sufficient to supply their wants, and to cause the productive capacity of the country to be enormously increased. No one could over-estimate the importance of that to a small country like England, which was so densely peopled, and so dependent on the world at large for its supplies of food. He had been very much struck by the figures given. The quantity of raw coal which was coked was stated to be 20 million tons, and if that were capable of producing valuable products to the extent of $3\frac{1}{4}$ millions, it was an enormous gain. He knew something of coking, having ovens of his own, and, therefore, he could quite understand that an apparatus of this simple nature could easily be applied to the coke ovens of the country. If such benefit as had been stated were likely to be derived from such an application, there could be no question that, before long, every coke oven in the country would be furnished with an apparatus for condensing the valuable bye-products, which were now wasted in the air. Undoubtedly, that could not be effected without the loss of a certain amount of coke; but then they were informed that that which was lost was the frothy bad coke which was always at the top of the charge. If they could supply any portion of the oil which was now being imported from America, that also would be a clear gain. The excess of our imports over exports was a matter which alarmed many, but it was really not so alarming if they took into account the dividends in foreign securities. It would be still less so if the country could be enriched by being self-producing, and if they could save the money which was now expended in artificial manures, and in the purchase of mineral oils. By the process which had been described, undoubtedly there would be a great acquisition to the wealth of this country, and if it could be done with comparatively so small a quantity as twenty millions of tons, what might they not hope for if the same process could be applied to the vast amount of raw coal which was used throughout the length and breadth of the land. Almost every steam-boiler in the manufacturing district was worked by raw coal; if instead of using raw coal, they could use the raw coal in the first instance for the production of these valuable products, and then use the coke from the coke ovens, there could be no doubt that the advantage of that system would very soon be appreciated. Whether this process could ever be applied to domestic fires was a matter which many might doubt. He could confirm what had been said by Mr. Walter Browne with regard to the satisfactory working of gas fires in ordinary rooms. Coke formed an excellent means of warming rooms in ordinary fire-places, and, at the present time, the House of Commons was warmed by coke fires. Nothing could be more barbarous than to use the hydro-carbons which were capable of producing such valuable results in the way they were used, by throwing them into the atmosphere, and defiling everything in the surrounding neighbourhood. Paris was chiefly heated by non-gaseous coals obtained from South Wales; and a time would come, no doubt, when London would be as bright and joyous as Paris, if we, like the Parisians, used very little bituminous coal. In conclusion, he begged to propose a hearty vote of thanks to the reader of the paper.

Mr. LIGHTFOOT, in reply, stated that the Tables which had been presented that evening did not represent the best results that had been obtained, but gave averages taken over a considerable period with different kinds of coal. Mr. Newlands had mentioned that the amount of ammonia was from 2 to 13 lbs. per ton of coal; but this was not quite correct, as in some cases as much as $17\frac{1}{2}$ lbs. had been recovered. The apparatus in use at Felling was certainly of very primitive construction, and it seemed as if this augured well for the future success of Mr. Jameson's process, for if such satisfactory results could be obtained at Felling, it was a fair

deduction that much better ones might be looked for with more perfect appliances. With regard to Mr. Coles's remarks, there was no doubt that, in order to develop an indicated horse-power in a gas-engine, a much larger quantity of coke-oven gas would be required than if ordinary coal gas was used, probably about four times as much, but the cost being less, the price of an indicated horse-power would be reduced considerably below what it was at present. The value of the gas had been taken at 3d. a thousand cubic feet, so as not to exaggerate the saving to be anticipated by the adoption of the recovery process, but he thought it quite possible that, in many instances, 6d. would be nearer the mark.

The vote of thanks having been unanimously carried, the meeting terminated.

Miscellaneous.

PROPOSED NEW SUEZ CANAL.

A preliminary meeting was held at Cannon-street Hotel, on the 10th inst., to consider the possibility of constructing a second Suez Canal, at which there were present representatives from the Peninsular and Oriental Company, the British India Company, the Ducal Line, the Orient Line, the Anchor Line, the Harrison Line, the Clan Line, the Eastern and Eastern Extension Telegraph Company, the Shire Line, and the Glen Line. It was estimated that the tonnage passing through the Canal represented by the gentlemen who were present in the room was not less than 3,000,000 tons.

In the course of the proceedings, it was stated by Mr. Stephen Ralli that even if the Suez Canal was not already inadequate to the requirements of the trade, it would soon become so. The trade between the far East and Europe had been of late years increasing at a very rapid and unexpected rate. There was, moreover, every probability that it would continue increasing. Taking it for granted that the concession given to M. de Lesseps prevented, for 99 years from the opening of the present canal, the constitution of another company having for its object the making of a new canal through the Isthmus of Suez, it must be borne in mind that treaties between nations, although in most cases made in perpetuity, were altered as soon as the circumstances which brought them about were altered. Mr. Ralli thought that the proper steps to take must be to try first to come to terms with the present company of the Suez Canal, asking from them what was wanted by the requirements of the rapidly increasing trade between the far East and Europe. He thought that what should be asked could be summed up in the following points:—(1) In consideration that the amount of British shipping passing through the Suez Canal was equal to four-fifths of the whole, and that the trade was principally carried on between India (which is a British dependency) and Europe, they could fairly ask from the French company that its Board should be reconstituted on a different basis, and that, instead of having three English directors against twenty-one French, the number of English directors should be equal to that of the French; (2) that the annual meeting of the company should be held alternately in Paris and in London; (3) that either the present canal should be very much widened, or another canal made. If a large widening of the present canal would cost nearly as much as the construction of a second, the construction of a second would be preferable, as it would allow the steamers to come up through one canal and go down through the other.

Resolutions were unamiously carried in favour of another canal, and an executive committee was appointed to take the necessary steps in furtherance of this object.

The first two resolutions were as follow:—"That having regard to the great increase of traffic, to the insufficiency of the present canal, even for the present traffic, and to its further certain increase, the time has arrived when arrangements should be completed for making a second canal;" and "That a committee be appointed to examine in detail the best course for such additional canal to take through Egypt, with authority to employ whatever professional assistance may be necessary for that purpose." A further resolution had reference to the appointment of an executive committee, and to the immediate formation of a guarantee fund to cover preliminary expenses. Among the gentlemen who were selected to act on this committee were—Mr. J. Laing (President of the Chamber of Shipping of the United Kingdom), who was appointed chairman, Mr. Thomas Sutherland (chairman of the Peninsular and Oriental Steam Navigation Company), Mr. John Glover, Mr. Pender, M.P. (chairman of the Eastern and Eastern Extension Telegraph Companies), and Sir George Elliot, M.P.

It was stated in the discussion, that those who are most competent to judge were of opinion that steamships in the Indian trade were increasing at such a rate, that the canal traffic was likely to exceed ten million tons before a second canal could be built, and it was contended, having regard to the serious inconveniences which are experienced with the present traffic, that the conduct of the business will become almost impossible when it grows to ten million tons, unless there be a second canal by that time. It was argued that, if the present traffic is paying the shareholders of the existing Suez Canal from 15 to 20 per cent., another canal would pay, even if the dues were lowered to five francs a ton.

FOREST CULTURE IN GERMANY.

Forests in Germany were originally common property, ownerships of forests being unknown. Of the lands suitable for agricultural purposes each one took

possession yearly of a fixed portion for cultivation. From the forests, however, each one took as much as he desired, and from wherever he pleased, excepting those groves which were set apart for religious purposes. Traces of the ownership of forests by private persons are found in the 6th century. At this stage of proprietorship, one could not claim particular woods, and prohibit the use of the same by others, unless the felling and using of the timber had actually commenced. Mr. Zimmerman, the United States Consular Agent in Berlin, states that the earliest forest properties were so-called privileged forests. By privileged forests are meant such as were the property of emperors, kings, princes, and other rulers and nobility. The privileges at first extended only to the exclusive right of hunting, fishing, &c., in the forests; but later, complete control of them was claimed, and they were appropriated by the nobility, and held as property belonging solely and entirely to themselves. In the earliest times, traces of forest protection and preservation are to be found. In the middle of the 13th century, a penalty of three "schillings" was attached by law to the cutting of wood in a forest without permission. After the privileged forests, came the private proprietorship of forests, then the county forests, and, lastly, the State forests of to-day. The laws and regulations under which the utilisation of forests was most justly and equitably permitted, occur between the years 1500 and 1800. Proper management of forests and discretion in felling the trees first began to be practised in the mining districts. Then it was necessary to have at hand the wood absolutely required there in connection with the working of the mines, and the mine owners were compelled to preserve the existing forests. After the mining districts, the forests in the neighbourhood of cities and towns began to be cared for. The "Erfurt" forest economy dates back as far as 1359. In the Nuremburg district in 1368, and in the Frankfort-on-the-Main district in 1423, the planting of the pine tree was introduced. The first forest schools were established in Germany about the year 1717. They were so called high schools, in which certain district officials (Revierverwalter) were the teachers. These schools were at first self-supporting, later, they received assistance from the State, or were made State forest schools or academies. Thus, forest academies were established at Dreissigacker in 1801; Tharandt in 1816; Nelsungen in 1816; Aschaffenburg in 1820; Hohenheim in 1820, and at Eisenach in 1830. To each of these academies three professors were detailed for duty, one to instruct in forest economy, one in natural history and science, and one in mathematics. In Baden, forest culture was added to the list of subjects studied at the Polytechnic Institute at Carlsruhe in 1832, and in 1838 the same was done at Brunswick. A chair of forestry was established at Giessen in 1825, and later also at Heidelberg, Munich, Tübingen, and Leipsic. At the last three, however, because of the forests being too remote for the practical instruction necessary for a student of forest culture to have, and for other reasons, the subject was dropped. In Prussia, the incitement to the study of forestry came from the State. From 1770, on the proposition of Minister Van Hagen, lectures on forest botany were delivered at Berlin, and excursions into the forests were made for the purpose of examining on the spot the subjects treated in the lectures. In 1821, a forest academy was established at Berlin, in connection with the university there. This academy was, in 1830, removed to Eberswalde, where it now is. The instructors at this academy consist of the director, three master foresters, and five professors, and the subjects taught are as follows:—Forest culture, in general, method of forest appraisement, the manner of keeping and rendering accounts of income received, and expenditures made on account of forests; the protection of forests, utilisation of the same, and huntsmanship, history of forest culture, and statistics relating to same, geodesy and draughting, mathematics, physics, and mechanics, botany, zoology and entomology, mineralogy, geology, and chemistry, and Prussian civil and criminal law. Excursions are made into the forests three times weekly, and lectures and practical demonstrations are then given. In 1868, a second Prussian forest academy was established at Münden on the same principle, and with nearly, if not quite, the same course of instruction. In the opinion of Professor Daukelmann of the forest academy of Eberswalde, a reorganisation of this course of study will take place within the next ten years, so that forestry subjects alone, such as preservation and cultivation of forests, botany, zoology, &c., will be taught at the forest academies; and general or relative subjects, such as geodesy, draughting, mathematics, and law, will be made a separate course for the forestry student at a university. Before admittance to the forest academy can be obtained, the applicant must be over twenty years of age. He must also have certificates to the effect that he has passed the requisite final examinations at a Prussian gymnasium, or "realschule" of the highest grade, that he has passed his examinations as *élève* forester, and that he has a good character, and possesses the means necessary for his subsistence while studying at the academy. A thorough forester, in Prussia, is an adept in natural history relative to forests and their inhabitants, at the same time a geologist, botanist and chemist, and the possessor of a good general knowledge of the laws of his country. He knows every foot of land in his district, at the various stations he notes the rainfall, the force and direction of the prevailing winds, their humidity and dryness, the temperature, &c. For the encouragement and assistance given to these men by the State, the return made by them in the management of its forest interests is of the greatest value. The Prussian forestry corps at present consists of 1 chief general master forester, 3 general master foresters, 30 chief master foresters, 1 forest director

in Hanover, 93 master foresters, 685 chief foresters, 3,354 district foresters, 356 forest keepers, and 70 minor officials.

FURNITURE EXHIBITION.

The Furniture Trades Exhibition at the Agricultural-hall, Islington, has immediately succeeded to the Building Trades Exhibition, noticed in the last number of the *Journal*, and, as might be expected, there are several points of contact between the two, but on the whole they may be considered as quite distinct in character. This is the Third Annual Furniture Exhibition that has been held at the Agricultural-hall, and it was opened on April 23rd, and closed on May 16th. The main building was largely devoted to what we chiefly understand by furniture, that is, upholstery; and a considerable variety of objects and styles of decoration were exhibited. In the sides and in the galleries a very liberal interpretation of the term furniture was taken, but as in the Building Exhibition the main feature was structural, so in this Exhibition the objects were chiefly connected with the contents of the structure. This classification did not, however, entirely hold good, for greenhouses and horticultural buildings generally had a special division set apart for them.

A considerable number of wood-working machines were shown in action, and numerous specimens of new processes of wood-carving, by which lengths of mouldings can be produced at a small expense, were exhibited. In the King Edward's-hall, which was devoted to domestic appliances, were exhibited a large number of useful objects. Here were shown specimens of pottery made from iron slag, and decorated in green, blue, and brown colours; and basins, trays, waiters, &c., made from pulp by the Patent Pulp Manufacturing Company, which are said to be practically unbreakable. The galleries were devoted to pianos, of which there were a large number; to carpets, chairs, stoves, and also to some of the lighter objects for exhibition. Messrs. H. R. Willis and Company, of Kidderminster, showed a three-quarter Brussels power-loom, by Messrs. John Crossley and Company, at work. The loom is constructed to weave Brussels velvet (or cut pile) carpet, and is provided with the necessary changes to weave ordinary loop Brussels by a special construction of the Jacquard, and it can be arranged to weave either five or six-frame carpet. Messrs. Cardinal and Harford showed a small loom for the making of Turkey carpets, brought from Koula, in Asia Minor. This is very roughly-constructed of such materials as came to hand, the appliances being of a very rude character. It was intended to show this loom at work, but owing to the impossibility of prevailing upon a Moslem family to leave Turkey, the idea had to be abandoned. The Institut de Sculpture sur Bois, at Brienz, sent over to the Exhibition some native workpeople, who were to be seen at work in the west gallery, surrounded by specimens of the wood-carving for which Switzerland is so famous. In the Oriental Bazaar, arranged by Messrs. Holme and Co., the various articles were set out in stalls, each of which was devoted to the town from which the articles are obtained or shipped, thus, under Tokio was shown porcelain and pottery from Tokio, Ota, Satsuma, Kaga, &c.; under Canton, furniture, gongs, &c.; under Benares, chased silver work; under Karachi, Scinde pottery; under Bombay, carved sandal wood, and inlaid box-work and furniture; under Constantinople, Syrian, Turkish, Bulgarian, and Persian embroideries; under Tunis, lanterns, slippers, &c., and so on, making eighteen eastern towns in all. Of other more general exhibits, mention may be made of various specimens of stained glass, and of the new imitation called "glacier," shown by Messrs. Perry and Company. This material is supplied in pieces of different sizes, and is affixed to the glass simply by wetting the glass uniformly and then applying the design. It is stated that it will not crack or leave the glass under the action of heat or moisture. A large collection of morocco leathers of special dyes were shown, as well as the new Caiman and Zeddo grains. The material called "veloplastic," which is made to imitate leather, silks, damasks, &c., is used for upholstery purposes, dressing bags, fancy leather goods, and even for bookbinding. The Yale Lock Manufacturing Company exhibited a large supply of their special locks and keys, among which was their time-lock, which, isolated from an external communication, can be set to be opened at any predetermined hour.

Printing and printing processes were also represented in the Exhibition. Messrs. Wyman exhibited the "Cyclostyle," a copying apparatus, the advantages of which are stated to be that (1) copies are in a permanent jet black colour; (2) any number of copies, from 10 to 2,000, can be obtained from one original writing; (3) no washing, no damping, no melting, and no press required; (4) the original may be left for any length of time, and further copies taken from it when wanted; (5) the last copy is at good as the first. Messrs. Blades, East, and Blades, had their machinery at work, and they printed the *Furniture Exhibition Chronicle* daily. Messrs. Blades are the printers and designers of the catalogue of the Exhibition, which is got up in the old English style, and is said to be "Sold by ye little Maydens for three groats onlie."

CHICORY AS A VEGETABLE.

In Holland, Belgium, and the Grand Duchy of Luxemburg, the *Cichorium intybus*, or common chicory, is improved by cultivation, and eaten as a vegetable, being called in Flemish "witteloof" (white leaf), like the allied plant, endive. It is very agreeable to the palate and highly nutritious; it is said also to possess tonic pro-

perties. This plant is especially valuable, as it comes in during first four months of the year, when other vegetables are scarce. The following directions for its cultivation are summarised from a contribution by M. Paris to the "Belgian Journal of Practical Agriculture":—In October, a bed is made in a light, sandy soil, dry rather than damp, four or five feet wide, and of a depth proportionate to the quantity of chicory that it is desired to force. The surface of this bed, to the depth of four or five inches, is thrown to either side; and the subsoil turned over nine or ten inches deep. The chicory roots are pulled up, and the tops cut off, leaving only an inch above the root. A cross trench is then made in one end of the bed, and the roots are planted therein upright, close together, so as to form a row two or three inches wide. The soil is then banked up against this compact row of plants, leaving only the leaves projecting. Another row is planted from two to four inches distant from the former, and so on, until the whole bed is planted. All the surface soil that was before taken off and thrown on either side, is then replaced; and, when it has somewhat settled and sunk, four or five inches more of light rich earth are thrown over, so as to cover the roots with about nine inches of soil. When it is desired to bring the chicory on, that end of the bed which is to be taken first is covered with eighteen or twenty inches of fresh stable manure, well pressed down so as to heat. An equable temperature is maintained, either by adding more fresh manure, or by employing a straw covering. The young shoots, white and tender, soon force their way through the layer of earth, and may then be taken up for use from one end, but carefully, so as not to break them. Every twelve or fifteen days a fresh portion of the bed is heated, its size depending on the consumption, and this goes on until the month of April, when the plants sprout without forcing. They are cooked like sea-kale, that is to say, boiled till tender, and served with gravy or white sauce. The chicory is chiefly eaten with fowl and white meats, and is especially recommended to invalids and convalescents. In Brussels, the plant, deprived of refuse, is sold for about 2d. or 2½d. per lb. in January.

AN AIR-DRIVEN TRAMCAR.

The direct application of compressed air to the driving of tramcars was successfully demonstrated on Wednesday, 16th inst., to a large party of gentlemen interested in such matters, by the British Mékarski Air Engine Company. The Mékarski engine is no novelty as an independent engine, in which form it has already done good work in tramway hauling in this country. It is, however, as combined with a tramcar that it is new in England, although in this form it has been working tramway traffic successfully at Nantes, in France, for the last four years. The engine-house is situate at the depot of the London Street Tramways Company in the Camden-road, Holloway, and contains two 20 horse-power engines, with compressing cylinders, air receivers, and store-tanks for a reserve of compressed air at a pressure of 450 lbs. per square inch; steam being supplied to the compressing engines by two double-flued Lancashire boilers. The car is one of the ordinary cars of the London Street Tramways Company (who are the first to adopt the system) adapted for working on the Mékarski principle. The car has two pairs of wheels, one pair being used for driving and being connected with the working cylinders, which are 5½in. in diameter, with a 10-inch stroke, and in which the compressed air is used. This air is stored in a reservoir placed under the body of the car, and in passing thence to the cylinders it is conducted through boiling water and steam at 60 lbs. per square inch, carried in a vessel called a hot-pot. This vessel is charged at the depôt during the time occupied in charging the reservoir on the car with compressed air. This application of heat not only causes an expansion of the air, but prevents the formation of snow in the cylinders and at the exhaust. The moisture picked up also acts as a lubricant for the slide valves and pistons of the driving engines. The working pressure varies from 120 lb. down to 50 lb. per square inch, the variation being regulated by a special valve which gives the driver a means of minutely adjusting the pressure, and of perfectly controlling the engine, and consequently the vehicle. A hot-pot is placed at each end of the car, on the platform, and the driver and conductor have at present to change ends at the close of each run. By adopting a triangle at each end of the line, however, the cars in future will be reversed, so that in adapting the other cars of the company, as is intended, a hot-pot will be placed at one end only, and thus expense will be saved. The car is fitted with the ordinary driver's foot-brake, besides which there is a powerful air-pressure brake for use in emergencies, which will bring the car up in a distance slightly exceeding its own length. No noise whatever is made by the exhaust air from the engines, nor is there any steam visible, nor the smell of fire or engine lubricants. The car runs smoothly and well, as was demonstrated at the trial which was made upon the company's line, which runs the whole length of the Caledonian-road, between Holloway-road and King's-cross. The length is two miles, and it has several steep gradients and sharp curves on its course. The journey to King's-cross and back was accomplished in excellent time, and was in other respects a success. It is intended to fit the remaining cars on this line upon the Mékarski principle, and so by degrees to supersede the present horse traction. —*The Times*.

THE fifty-third meeting of the British Association will be held from September 19 to September 26, at Southport, and not, as misprinted in the last number of the *Journal*, at Southampton

Correspondence.

BOUNTY ON ELECTRO-PLATE.

I must ask to be allowed to make a correction in the concluding sentence in my remarks on Mr. Cripps's paper, which represents me as saying just the reverse of what I intended. Instead of the effect of the excise and import duties on gold and silver plate being "to prevent freedom of trade in electro-plated goods," those duties operate as a bounty and premium in favour of simulated plate, and as a deterrent from the manufacture and use of the sterling articles. Never was the incidence of any fiscal impost on an art-industry more obvious than in these levies on genuine gold and silver ware, being equal to nearly 40 per cent., in the latter case, on the metal itself. It seems to me that the Society of Arts, especially on its artistic side, is bound to use its influence towards the abolition of these barbaric imposts.

I ventured to suggest that as some official, though optional, test of the genuineness of gold and silver plate will probably be required after the rapidly approaching abolition of the compulsory "stamping" and "scraping" shall be attained, her Majesty's Mint Master is the proper authority to undertake that delicate and responsible function. That such powers should be left so long in the hands of a semi-private, antiquated, and "irresponsible corporation" is one of the anachronisms of our day.

W. MARTIN WOOD.

West Kensington, May 14th, 1883.

Obituary.

JAMES YOUNG, F.R.S.—On Sunday, the 13th instant, died at his home, Kelly, near Wemyss Bay, Dr. Young, the eminent chemist, who had been a member of the Society of Arts for six-and-twenty years. James Young was born in Drygate, Glasgow, in July, 1811, and after receiving an elementary education in one of the Scotch parochial schools, assisted his father in his business as a joiner. At the age of eighteen, however, he was attracted by the lectures of the late Thomas Graham, afterwards Master of the Mint, then a lecturer on chemistry at the Andersonian Institute, and, in 1832, he became his assistant. In this position he continued for seven years, part of the time in London, where his principal had become one of the Professors at University College. In 1847, his attention was first drawn to a petroleum spring in a coal mine in Derbyshire. Submitting the oil to long and careful examination, he, with the aid of Mr. Meldrum, the manager of the works at Alfreton, succeeded in obtaining from the spring a lubricating oil for machinery and a lighter oil for consumption in lamps. When the supply came to an end, he continued his experiments, and discovered that by the slow distillation process oil was readily to be obtained. Obtaining a patent for his discovery, the town of Bathgate, situated between Edinburgh and Glasgow, was settled upon as the spot for carrying on the works, owing principally to the richness of the coal obtained in the district. Here large works were set up, and proved very successful. Mr. Young was also the originator and manufacturer of paraffin candles, which became an extensive article of commerce. He established at Anderson's College—where, as the Andersonian Institute, he had obtained his first knowledge of chemistry—a Chair of Practical Chemistry, which he endowed with a sum of fifteen thousand guineas. Besides presenting to Glasgow a statue of Professor Graham, he printed privately a collected edition of his works. He was a life-long friend of Dr. Livingstone, and fitted out an expedition to Africa in search of him. In 1873 he was elected a Fellow of the Royal Society, and he also occupied the position of Vice-President of the Chemical Society.

General Notes.

VIENNA EXHIBITION OF GRAPHIC ARTS.—An International Exhibition of Graphic Arts, under the patronage of the Archduke Louis Victor, will be held at Vienna from the 15th September to the 1st November next, in the rooms of the Association of Artists. The exhibits will be divided under the following headings:—(*a*) Engravings on copper; (*b*) etchings; (*c*) lithographs; (*d*) wood engravings; (*e*) drawings and water-colours made for the purpose of reproduction.

ELECTRIC EXHIBITION.—Information has been received from the Foreign Office, through the Science and Art Department, to the effect that an Austrian law was passed, on the 28th February, relative to the temporary protection of patented objects at the Vienna Electric Exhibition. Applications for certificate of protection are to be made as soon as possible by owners of objects, or by accredited agents, and to be accompanied by the necessary plans, drawings, and duplicates, together with the authorisation for the agent to act. These applications, and requests for more detailed information, must be addressed to the Privilegien Department of the Imperial Ministry of Commerce, Vienna. Certificates will take effect from date of entry to 31st December, 1883.

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

MAY 23.—"Technical Instruction in Elementary and Intermediate Schools." By PHILIP MAGNUS, B.Sc., B.A. The Hon. E. LYULPH STANLEY, M.P., will preside.

MAY 30.—"The Relative Claims of Etching and Engraving to Rank as Fine Arts." By F. SEYMOUR HADEN, F.R.C.S. Sir RUTHERFORD ALCOCK, K.C.B., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evening at Eight o'clock:—

MAY 29.—"Queensland: its Progress and Resources." By ARTHUR J. STANESBY. W. MCCULLAGH TORRENS, M.P., will preside.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evening at Eight o'clock:—

MAY 24.—"The Development of Electric Lighting." By J. E. H. GORDON, B.A.

INDIAN SECTION.

Friday evening at Eight o'clock:—

MAY 25.—"Some Notes on the Domestic Architecture of India." By C. PURDON CLARKE. Sir PHILIP CUNLIFFE-OWEN, K.C.M.G., C.B., C.I.E., will preside.

CANTOR LECTURES.

Monday evening at Eight o'clock:—

The Fifth Course, on "Secondary Batteries." By Prof. OLIVER J. LODGE, M.A., D.Sc.

LECTURE I.—MAY 21.

Method of storing electric energy; general principles of secondary batteries; advantages of lead; action of a Planté cell; improvements of Faure and others; process of manufacture as carried on by the Electrical Power Storage Co.; action of the cells in charge and discharge; measurement of electromotive force and internal resistance; indicator diagrams.

LECTURE II.—MAY 28.

Uses of the secondary battery in practice; laboratory purposes; motive power; action as a regulator; transmission of energy; lighting by means of water-power; locomotion on land; marine locomotion; efficiency of motors driven by batteries.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. O. J. Lodge, "Secondary Batteries and the Electrical Storage of Power." (Lecture I.)
Asiatic, 22, Albemarle-street, W., 3 p.m.
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m., Rev. J. Lias, "The Existence of God."

TUESDAY, MAY 22...Royal Institution, Albemarle-street, W., 3 p.m. Professor McKendrick, "Physiological Discovery." (Lecture VIII.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. Alexander Leslie, "Account of the Edinburgh Water Works." 2. Mr. John George Gamble, "The Water Works of Port Elizabeth, South Africa." 3. Mr. John Addy, "The Water Supply of Peterborough."
Statistical (Royal School of Mines), 28, Jermyn-street, S.W., 7¾ p.m. Mr. Rowland Hamilton, "Popular Education in England and Wales before and after the Elementary Education Act of 1870."
Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m.

WEDNESDAY, MAY 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Philip Magnus "Technical Instruction in Elementary and Intermediate Schools."
Geological, Burlington-house, W., 8 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

THURSDAY, MAY 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Mr. J. E. H. Gordon, "The Development of Electric Lighting."
Royal, Burlington-house, W., 4½ p.m. 1. Dr. W. Huggins, "The Function of the Sound-post of the Violin, and the proportional thickness of its Strings." 2. Professor Emerson Reynolds, "Note on the Atomic Weight of Glucinum (Beryllium);" and other papers.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 3 p.m. Annual Meeting.
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Charles Pfoundes, "Art and Literature of Old Japan."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. Stuart Poole, "Recent Discoveries in Egypt." (Lecture I.)
Inventors' Institute, 4, St. Martin's-place, W.C., 4 p.m. Annual Meeting.
Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Prof. D. E. Hughes, "On the Cause of Magnetism." (Illustrated by Experiments.)

FRIDAY, MAY 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. C. Purdon Clarke, "Some Notes on the Domestic Architecture of India."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. Flower, "Whales."
Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, MAY 26...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. G. Griffiths, "On the Graphical Representation of Musical Intervals." 2. Mr. J. A. Fleming, "On a Phenomenon of Molecular Radiation in Incandescence Lamps."
Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Turner, "Historical Sketches of Russian Social Life." (Lecture II.)

Journal of the Society of Arts.

No. 1,592. Vol. XXXII.

FRIDAY, MAY 25, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's Annual Conversazione will be held this year in the Buildings of the International Fisheries Exhibition. The date and particulars of the arrangements will be announced when the date is fixed by H.R.H. the President.

CANTOR LECTURES.

The first lecture of the course, on "Secondary Batteries and the Electrical Storage of Power," was delivered on Monday evening, 21st inst., by Professor OLIVER LODGE, M.A., D.Sc. The lecturer explained the method of storing electric energy, and the general principles of secondary batteries, showing the action of a Planté cell, and the improvements of Faure and others.

The Electrical Power Storage Company exhibited portions of their secondary batteries, to show the process of manufacture.

The lectures will be printed in the *Journal* during the autumn recess.

PREVENTION OF FIRES.

A public meeting will be held on Thursday, May 31, at 3 p.m., to consider the question of the prevention of fires in theatres. Sir WILLIAM SIEMENS, F.R.S., Chairman of Council, will preside.

Persons not members of the Society wishing to attend should apply to the Secretary for tickets.

PRACTICAL EXAMINATION IN VOCAL OR INSTRUMENTAL MUSIC.

The next Examination in London will be held at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing on the 11th June, 1883.

Proceedings of the Society.

PREVENTION OF FIRES.

The following Report of the Committee of the Society will be presented for discussion at the meeting to be held on Thursday afternoon next:—

The information already available to the public on the subject of fires in theatres is so extensive, that the Committee find themselves able to add very little to it. The subject was inquired into by a Select Committee in 1866, and again in 1876 and 1877. On both occasions, a large amount of evidence was taken, and the information regarding the condition of the London theatres at that date is as full as need be desired. Much available information is also contained in the Annual Reports of Captain Shaw, the chief officer of the Metropolitan Fire Brigade, to the Metropolitan Board of Works, and also in a pamphlet published by the same gentleman on "The Prevention of Fires in Theatres." Captain Shaw has also recently made special reports to the Metropolitan Board of Works, on the condition of all the London theatres. These reports, except that on the Gaiety Theatre, which has been printed by Mr. Hollingshed, have not been published; but the Committee are given to understand that they are of a very full and exhaustive nature. The Committee cannot but think that the public circulation of the information they contain would be attended by beneficial results, even though some of it should place particular theatres in an unfavourable light. It it be a fact that any theatre is in a dangerous state, the public ought to be informed. Supposing any serious accident to occur in such a house, there can be no doubt that a very grave responsibility

would fall on the shoulders of those who have kept back the knowledge which might have saved valuable lives.

The Society has itself dealt with the question, so far as water supply is concerned. In 1875, a Committee reported on the means of protecting the metropolis from conflagrations and, in 1877, a second report was issued by the same Committee, on fires in theatres. At the present time, the Committee, acting upon the information at their disposal, have thought it well to prepare a series of suggestions, which may be taken as representing the opinions of those best qualified to judge, as to the points which should be attended to in the construction and management of a theatre, with reference to the protection of the public from loss of life by fire, or from the even more serious loss of life which would certainly occur from panic caused by the breaking out of a fire, however small its extent.

How these suggestions should be put into actual practice is a point with which the Committee have not dealt. The question of the licensing, inspection, and general regulation of the theatres, not only in London, but in the provinces, is so large a one that they have considered it wiser for them to keep to one special portion of the subject. It may be sufficient to note that the theatres within the metropolitan boroughs, and defined in the Act of 1832, are, with the exception of the two old Patent theatres, Drury-lane and Covent-garden, under the jurisdiction of the Lord Chamberlain. These theatres are annually licensed by him, and the license can be revoked in extreme cases, but there is no power to suspend a license for a time, or to inflict any penalties less than the suspension of the license. The Lord Chamberlain issues regulations for the management of the theatre, and once a year an inspection is made. It is believed that these regulations are fairly well attended to, at all events when the period for inspection approaches, but whether they are attended to or not seems to depend principally upon the good feeling of the managers of the theatres. Theatres, in common with all places of public entertainment, come under special provisions in the Metropolitan Buildings Act. These provisions require that the floors and passages, stairs, &c., should be of fire-proof material, and carried by fireproof supports; also that the whole of the building should be constructed in such a manner as may be approved by the District Surveyor, or, in case of disagreement, by the Board. It is under this Act that the Board directed the recent inspection of theatres by Captain Shaw.

The Committee are much indebted to the Secretary of State for Foreign Affairs, who has been good enough to procure for their use copies of the regulations in force in Belgium, in Berlin, and in Vienna. Summaries of these regulations will be published hereafter as Appendixes to the report. Another Appendix contains an account of the researches which have been made, with a view of discovering some material which might be applied to fabrics and to combustible materials, generally with a view of preventing them from taking fire. For the account of these researches they are indebted to one of their number, Sir Frederick Abel. The points which, in the opinion of the Committee, should be attended to in the construction, &c., of theatres, may be classified as follows :—

a. Structural (including arrangements for heating, and with special reference to exits).

b. Arrangement and treatment of scenery and accessories.

c. Arrangement of illuminating appliances, and stage effects involving the use of gas, pyrotechnic compositions, &c.

d. Regulations, organisation of fire-brigades, &c.

(*a*.) STRUCTURAL.—These are certainly the most important of all. First, the building itself should be constructed in a manner calculated to check the spread of a fire. To this end it should be divided as much as possible by fire-proof partitions, and above all, there should be a division between the stage and the auditorium, extending from the base to the roof. The opening from the stage in this partition should be defended by a metal screen, or a fireproof curtain of some sort, though it appears from the experience of the fire at the Berlin National Theatre, that the iron curtain actually tore down part of the wall, so that this means of protection has its objectionable features. Perhaps the curtain devised by Capt. Shaw, which can, in a very few minutes, be saturated with water, would be effective to this end. There should be an ample water supply, either by reservoirs at sufficient height, or by connection with the street supply—the latter for preference. Hydrants, and other proper fittings, should be provided in abundance. The Com-

mittee have had a favourable account of the action, in some warehouses in America, of an arrangement for deluging any part of a building by a shower of water from fixed perforated pipes. They, however, have no information as to whether this arrangement has been used for theatres, and can offer no opinion from their own knowledge upon its merits. Means should be provided for carrying off smoke and heated air, in case of a fire breaking out on the stage or amongst the scenery, so that they may pass away, instead of being, as would now nearly always be the case, drawn into the body of the theatre by the draughts usually existing. It is desirable that a theatre should be, as far as possible, separated from adjoining buildings, especially from buildings in which any trade or business is carried on likely to lead to fires. The same provision is also of importance with regard to exits, it being of the greatest consequence that a theatre should discharge its audience into more than one street, even, if possible, into more than two. The different parts of the theatre should have different exits leading right out to the street, exits bringing streams of persons together being specially dangerous. Such exits should increase in width outwards, and should be free from interruption or impediment of any character. Steps in passages, either ascending or descending, should be avoided, and any other obstruction likely to cause people to fall. All doors should open outwards. Staircases should be properly fitted on both sides with hand-rails. As regards heating, it does not appear that special arrangements are generally adopted for heating theatres, except by means of ordinary fire-grates in refreshment rooms, lobbies, &c. Should the electric light come into general use for lighting theatres, it is possible that they will require to be specially warmed, in which case the usual precautions will have to be employed.

(*b.*) ARRANGEMENT AND TREATMENT OF SCENERY AND ACCESSORIES.—As regards the scenery and the lighter sort of costumes, there seems to be no doubt that measures ought to be taken to render these uninflammable, or at all events, not easily inflammable. For fabrics the best material seems to be tungstate of soda, and this has been successfully employed in some theatres. Mr. Henderson, at that time the proprietor of the Criterion Theatre, giving evidence before the House of Commons Committee of 1877, said that he used it, and that there was no difficulty in its use as regards new scenery; to old scenery, he said, it could not be applied. There appears to be no reason why the woodwork of scenery should not be treated with silicate of soda, either with or without a lime-wash, after the method described in the Appendix.

The Committee are not aware whether this actual process has been applied; they would be glad to know that experiments in this direction had been made; but they are informed that the scenery of some London theatres are now treated with some of the more recently invented preparations, most of which, it is understood, have a silicate or a borate for their basis. The effect of all such preparations is, that it coats the articles, or, in case of fabrics, the fibres of the articles, with a non-inflammable substance. This does not prevent the evolution of gas from the material when sufficient heat is applied, and the gas thus evolved takes fire, and burns. When the source of external heat is removed, no more gas is evolved, and combustion ceases. Thus it may be said that the article will burn when exposed to sufficient heat, but has not, in itself, the power of supporting combustion. One effect of this is, that it is very much more difficult to set such materials on fire, and this alone is sufficient either to prevent the breaking out of fire at all, or to render it much easier to deal with after it has broken out.

(*c.*) ARRANGEMENT OF ILLUMINATING APPLIANCES, AND OF STAGE EFFECTS INVOLVING THE USE OF GAS, PYROTECHNIC COMPOSITIONS, &C.—There is not much to be said about the ordinary lighting arrangements. In all theatres they are generally under the control of a special gas-man. It is desirable that precautions should be taken for the ventilation of places in which the meters are fixed, generally underground cellars, to avoid the risks of explosions.

When electrical illumination is employed, the necessary precautions should of course be taken; in fact the rules laid down by the Society of Telegraph Engineers apply equally well to theatres as to other buildings. Whatever system of illumination may be employed, whether gas or electricity, it is absolutely necessary that oil or candle lamps should be fixed up in the passages, and near the doors, so that, in case of the failure of the ordinary lighting arrangements, the audience may not be left in the dark. This is now done in many theatres, and ought to be done in all. Curiously enough, it has happened that these lamps have proved a source of danger,

as a theatre in Hungary is reported to have been burnt by one of these "alternative" lamps.

The lighting arrangements for the stage are often very dangerous. The rules which now exist as to the use of naked lights upon the stage ought to be strictly adhered to. All lights should be, and in many theatres are, carefully protected; the footlights should have a grate before them; the wooden battens over the stage, carrying rows of gas lights, should never be allowed.

Small accidents have, it is understood, not unfrequently occurred from the careless use of the oxy-hydrogen light. This light, when carefully employed, is perfectly safe, but in the hands of careless or inexperienced persons it is liable to give rise to explosions of a dangerous character. The causes of many of the explosions which have occurred, not only in theatres, but during other exhibitions where the light has been used, have not always been traced, but probably in many cases they are due to the gases having become mixed in one of the bags. A bag in which a little hydrogen remained may have been, by mistake, filled with oxygen, and thus a mixed gas of a very explosive character produced. Another source of these explosions is sudden alteration of pressure upon the bags, by which the mixed gases are drawn back into one of the bags, when a similar result occurs. It would be well if the very simple device were employed of storing the gases, when the ordinary coal-gas mains are not employed, or the oxygen gas when they are, in proper gas-holders outside the walls of the theatre, and laying the gas or gases on in the same way as ordinary illuminating gas is laid on.

The use of pyrotechnic compositions is a common source of danger, and it is believed that many of the most serious fires are due to them. Portions of the material are left about after the conclusion of the performance, become ignited, and the result is a fire. Some of these compositions have, moreover, been proved to be capable of spontaneous ignition. Wherever these materials are used—and it would probably be useless to attempt to stop their use—the greatest precautions ought to be taken. In some places, burning houses have been introduced on the stage. This is certainly a most dangerous practice, and might well be forbidden.

(*d.*) Regulations, Organisation, &c.—There appears to be a good deal of doubt whether it is best to leave the arrangement for the detection and extinction of fire in the hands of the regular *employés* of the theatre, or to have special firemen for the purpose. The report of the 1877 Committee was in favour of the former system; but the latter seems to be coming generally into use. At most of the chief theatres of London, one or more trained firemen, generally old members of the Fire Brigade, are employed. Mr. Ponsonby Fane quoted a remark to the effect that that the best prevention of a fire in a theatre was the carpenter's cap, because, directly the carpenter saw a fire beginning, he took his cap off and knocked it out.

All the *employés* ought to be trained how to act in the case of fire, inasmuch as on their presence of mind must obviously depend the safety of the audience. They are familiar with the locality, and they are of course accustomed to dealing with crowds of people. Strict regulations ought to be enforced, with the view of preventing the common practice of filling up gangways with chairs, which, in the case of panic, would form really serious obstacles to the escaping crowd.

How the regulations for the safety of theatres should be enforced is a question with which, as stated at the commencement of the report, the Committee do not propose to deal; nor are they prepared to offer any opinion as to the amount of inspection which would be desirable, or as to how far managers should be made responsible, and the carrying out of the regulations left to them. It appears to be the general opinion amongst those best qualified to judge that the strict regulations—for instance in the French theatres—are by no means productive of good. Mr. Hollingshead, in his evidence before the 1877 Committee, spoke rather strongly on this point, and gave evidence to show the bad working of the rules. According to him, the responsibility was so much divided between the director of the theatre and the *sappeurs-pompiers*, that there was even more liability to fire than in English theatres. He gave an instance of interference in the arrangements of a piece he had sold to the Porte St. Martin, in which the police would not allow the scenery to be set up or lighted properly, and the result was that the whole tumbled down, and caused a panic amongst the audience, by scattering an enormous number of splinters of glass about. At all events, it is a remarkable fact, somewhat bearing upon this portion of the report, that according to a statement in the 1877 Report,

not a single life had been lost by fire amongst theatrical audiences for 50 years preceding, and the same statement might, it is believed, be made at the present time. Many, however, have been lost by panics in theatres during the same period, and this certainly goes to show that precautions against panics should be even more carefully taken than precautions against actual fire.

In concluding the report, the Committee wish to draw attention to a proposal recently brought before the Society by Mr. Cornelius Walford, in his paper read on the 28th February last, upon "Loss of Life and Property by Fire"—the proposal that an inquest should be held in cases of house burning when there had been no loss of life. The suggestion appears to have been first made in the year 1845, by Mr. Serjeant Payne, then coroner for London and Southwark. It has been since brought forward by his son, Mr. W. J. Payne, the present coroner for Southwark; and the letter which Mr. Payne, in 1873, addressed to the *Times* on this subject was reprinted in the *Journal* which contained Mr. Walford's paper. For a short time the plan was actually put in execution by Serjeant Payne, who, on receiving information that a house had been burnt, granted a warrant for a jury and witnesses in the same way as in the case of an inquest when death occurs; but the system was put an end to by a decision of the Court of Queen's Bench. Such inquiries might be made either by the coroner, or by a special officer appointed for the purpose, and, if necessary, they might be only made in cases when the Chief Officer of the Fire Brigade reported that the case was one that required investigation. The Committee, however, content themselves with drawing attention to the question, without suggesting a scheme by which it might be carried into effect; and they would only remark that a precedent for such inquiries is found in the case of collisions at sea, and in railway accidents, since in both cases inquiries are carried on by the Board of Trade, even though there may have been no actual loss of life.

APPENDIX.

NOTES ON SOME OF THE VARIOUS AGENTS EMPLOYED TO RENDER MATERIALS UNINFLAMMABLE.

In March, 1855, M. Salomon, of Paris, submitted to the Board of Ordnance a method of rendering wood and canvas incombustible by treatment with soluble glass or silicate of potash. The same materials, employed in a different manner, had been suggested by Mr. (now Sir Frederick) Abel to render huts in the Crimea fireproof. M. Salomon's plan of mixing and applying the silicate was open to question, but the subject was of such importance, that Mr. Abel recommended to the Board of Ordnance the undertaking of experiments without delay, in which he proferred his assistance.

In August, 1855, Mr. Abel reported further on M. Salomon's process. Experiments were made with fireproof liquids of following composition:—

	Kilos.
1st Bath—Acid sulphate of alumina ..	30
Gelatine (glue).....	10
Water	60
2nd Bath—Dried choride of calcium ..	20
Gelatine (glue).....	10
Water	70

Glue having been dissolved by warmth, the salts were added. On the liquids being mixed, a mutual decomposition of the sulphate of alumina and chloride took place, forming sulphate of lime and chloride of aluminium, a soluble deliquescent body possessing the property, like other saline compounds, of precipitating gelatine from its aqueous solution, and converting it into an insoluble substance like leather. It was M. Salomon's intention to fill up the pores of the material treated with an insoluble substance unalterable by heat, and to produce a hard binding material on the surface with the precipitated gelatine. Some difficulty was found in preparing the first bath, owing to the tendeney of the gelatine to separate, but the second bath gave no difficulty. Some dry timber was selected, and a portion treated as suggested by M. Salomon, viz., by immersion first in the sulphate of alumina bath, and, secondly, after drying in the calcium bath, while another portion of the timber was treated in reversed order. Twenty-four hours was the time of immersion. Placed upon a charcoal fire beside unprepared wood, those treated by the Salomon process were slower to ignite, and, when withdrawn from the fire, did not smoulder so long. But when thoroughly ignited, the preparation was of no avail.

Canvas treated by the Salomon process was very difficult of ignition, but it was rendered rigid and harsh by the treatment.

In September, 1855, Mr. Abel reports on other methods for rendering wood, &c., fire-

proof. He enumerates Maugham's process, which consists in saturating dried wood with phosphate of soda and muriate or sulphate of ammonia, in certain proportions; that of Lieut. Jackson, by which wood is impregnated with a solution of salts of zinc and of ammonia. These processes, although they do, to a certain extent, diminish inflammability, are not cheap nor effective. Silicate of soda, on the other hand, offers many advantages, among these being that wood is easily coated, and that the coating is not deliquescent. Wood was soaked in a weak solution and dried, and then placed on a fire with unprepared wood, when the protective character of the silicate was fully established. A hut, built in the Marshes at Woolwich, was coated with silicate inside and out in one part, and another part with a mixture of lime and alum, when the protective character of the former was again demonstrated. After the hut had been burned, an examination of the charred planks proved that where the silicate had been applied, the fire had not completely penetrated.

Also, in September, 1855, Mr. Abel states that, by combining lime with silicate of soda, he has produced a fire-protective for application to wood, which resists the action of water as well. The fireproof nature of the mixture is superior to silicate alone.

In March, 1856, detailing the results of practical trials with silicate and lime, Mr. Abel establishes the effective character of the mixture. A circular of printed instructions was afterwards issued, and a paper was prepared on the subject, and printed in the "Aide Memoirs" of the Royal Engineers, for 1856. The process was afterwards applied, to some extent, to camp-huts at Aldershot, and silicate of soda alone was tried on the wood-work in the interior of the huts.

In August, 1857, Mr. Abel explains that the fifteen tons of material, forwarded to China, is not for experiment, but for use in coating wooden structures on that station; recommending also its employment in India, and explaining how it could be applied to thatched buildings. (The recommendation to send the silicate and lime mixture to China is explained to Sir B. Hawes, March 18th, 1857).

In July, 1859, Mr. Abel reports upon sail-cloth, supposed to be rendered uninflammable by a process applied by Messrs. Versmann and Oppenheim (see printed memorandum).

In July, 1859, Mr. Abel states that canvas and other fabrics may be rendered fireproof, or rather protected by fire, if the alkaline silicates are employed in a peculiar way, with other agents, and suggesting that application be made of this discovery.

In January, 1860, Mr. Abel submitted to the Ordnance Select Committee samples of fabrics rendered fireproof. Several saline bodies had been suggested for the purpose, but these were none of them trustworthy; in the canvas submitted, a material of a protective character had been fixed within the fibre of the fabric, a double lead and sodium silicate.

In March, 1861, Mr. Abel gave directions for trial of protected canvas made into tents, but reminded the committee that, obviously, nothing will prevent the fabric from charring, if great heat is at hand. The trial recommended was to ignite shavings in contact with the canvas.

In July, 1861, Mr. Abel reported that experiments had been made by him with clothing of men at the Royal Gunpowder Works, Waltham Abbey, and recommending, in lieu of ordinary clothing treated with protective material —which glows, on burning—the wearing of woollen fabric. The material called "lasting" was recommended, and was adopted throughout the powder works at Waltham Abbey in 1861, and afterwards in other powder works. Its use was made compulsory in all manufactories of explosives by the Explosives Act, 1875.

In December, 1870, Mr. Abel recommended, as protective coating for the interior of buildings in which manufacture of powder is going on, a material combining the qualities of the silicate of soda and lime coating, as already proposed by him for camp huts, with certain other qualities, such as its non-liability to retain dust-particles, and non-injury from washing. Mr. Abel suggests—(*a*) equal parts of whiting and zinc (by weight), mixed and ground together; (*b*) equal parts (by measure) of water and syrupy silicate of soda; (*c*) the mixed liquid to be stirred up with the whiting and zinc, and then applied like ordinary paint.

In July, 1871, Mr. Abel recommended the foregoing and also Torbay paint mixed with silicate. Also recommended, as before, the silicate and lime, for out-door work.

In February, 1872, Mr. Abel again called attention to the qualities of these protective coatings for indoor and out-door coatings.

In May, 1872, Mr. Abel recommended chloride of calcium for rope mantelets, so as to keep them damp, and prevent ignition by the firing of the guns. This recommendation was adopted, with very successful results.

In March, 1881, Mr. Abel stated that tungstate of soda (first proposed by Versmann

and Oppenheim as a protective for fibrics, see printed report to British Association, 1854) may be applied to wood and fabrics as a protection from fire; but believes it has no advantage for the first-named purpose over the soluble silicate material proposed 25 years previously.

In July, 1881, Mr. Abel reported on a fire-extinguishing liquid, submitted as consisting of a strong solution of common salt and soluble glass, and stated that it presents little novelty.

Chemist, W.D. To Under Secretary of State for War, 20th July, 1859.

The specimen of prepared sail-cloth, submitted by Messrs. Versmann and Oppenheim, has been most effectively deprived of inflammability by the treatment to which it has been subjected. When exposed to the action of a powerful heat or flame, inflammable vapour is evolved, which ceases to burn directly the canvas is removed from the source of heat, and the charred portions of the material ceases even to burn in a short space of time.

The protecting agent is so firmly fixed in the canvas, that it is not removed at all by friction or repeated washing. The protection afforded to the fabric may, therefore, be considered very permanent.

The only objections of importance which can be raised against the very efficient method of Messrs. Versmann and Oppenheim, of protecting canvas from fire, are :—

1. The great increase in weight which the fabric suffers, and which amounts to nearly 50 per cent. of the original weight of the canvas.

2. The comparative costliness of the protective agents employed.

The first of these objections is, to a great extent, inseparable from the efficient permanent protection of canvas and other fabrics from fire; as, in order to attain that result, it is necessary to impregnate the fabric completely with some material which will remain in it as an insoluble solid. I have reason to believe, however, that canvas may be thoroughly and permanently protected from fire, without suffering so great an increase in weight as that resulting from Messrs. Versmann and Oppenheim's method of treatment.

The agents employed by these gentlemen for the preparation of the canvas, are compounds of tin, one of the most expensive metals of commerce. The cost of an important process like that referred to, can only be looked upon as a serious objection to its employment when its object may be attained as effectively and permanently by a much cheaper method.

The process of protecting canvas from fire, to which I have called attention in a letter of this day's date, possesses the very important advantage of comparative cheapness over the process of Messrs. Versmann and Oppenheim.

I therefore beg to suggest that the protection of canvas from fire by the agency of silicates, as proposed by me, be made the subject of experiment in the first instance, and that the comparatively expensive process of Messrs. Versmann and Oppenheim be practically tested, should the silicates not fulfil my statements of their efficiency as protectives of a permanent character. . . . .

(Signed) F. A. ABEL.

The Comparative Value of Certain Salts for Rendering Fibrous Substances Non-inflammable.

At the meeting of the British Association at Aberdeen, in 1859, a communication on the above subject was read by Mr. Versmann and Dr. Oppenheim. The paper commenced with a consideration of the difference between animal and vegetable fibre; the first containing about 18 per cent. of nitrogen, and the latter consisting exclusively of carbon, hydrogen, and oxygen. Animal fibre chars, but is not inflammable, whereas vegetable fibre is. The first idea would be to introduce nitrogen into vegetable fibre by way of a protection, in some such form as glue or albumen. This could not practically be done, though the addition, by means of urea, of 13 parts of nitrogen to 100 parts of muslin, did render it non-inflammable. As early as 1735, a patent had been granted to Obadiah Wild, who applied a mixture of alum, borax, and vitriol to paper pulp. It is believed that paper made of this pulp was used for making cartridges. In the early part of the century the attention of many chemists was directed to the subject. Gay-Lussac, in 1830, proposed the carbonates of potash and soda. Fuchs suggested water-glass. The writers of the paper then proceeded to give an account of their own experiments. They commenced trying as many as forty different salts, and those salts which seemed preferable on account of the small amount required, were afterwards tested on a large scale in muslin manufactories or in laundries. Accounts are given of the behaviour of the following re-agents :—Chlorides of potassium and sodium, carbonates of potash

and soda, hydrate of soda, bicarbonate of soda, borax, phosphate of soda, sulphate of soda, bisulphate of soda, sulphite of soda, silicate of soda (water-glass), stannate of soda, tungstate of soda, cyanide of potassium, carbonate of ammonia, oxalate of ammonia, biborate of ammonia, phosphate of ammonia, the double salt of the phosphate of ammonia and soda, sulphite of ammonia, chloride of ammonium, iodide and bromide of ammonium, mixture of phosphate of ammonia and chloride of ammonium, chloride of barium, chloride of calcium, biphosphate of lime, sulphate of magnesia, tersulphate of alumina, potash-alum, ammonia-alum, sulphates of iron, copper, and zinc, chlorides of zinc, chlorides of zinc and tin, double salts of protochloride of tin, and chloride of ammonium, pink salt(?). The writers state that all inorganic salts applied in solution to fabrics diminish inflammability by absorbing heat and excluding access of air. Of all the salts experimented upon, only four appeared to be applicable for light fabrics. These were—

1. Phosphate of ammonia.
2. The mixture of phosphate of ammonia and chloride of ammonium.
3. Sulphate of ammonia.
4. Tungstate of soda.

The sulphate of ammonia was found to answer well for treating muslin in the process of finishing, but the muslin would not stand the heat of ironing. Only the tungstate of soda could be recommended for laundry purposes. In practice, in order to avoid the formation in solution of an insoluble bitungstate, it was found desirable to add a small proportion of phosphoric acid or phosphate of soda. The salts tested being all soluble, washed out when the fabric was wetted. Experiments were therefore carried on with the object of fixing the protective material of the fabric. For this purpose, attempts were made to fix sulphite of baryta, phosphate in alumina, and some silicates, by precipitating them by double decomposition in the fibre; these attempts were all unsuccessful. The oxide of zinc and alumina was found to protect the fibre, but it did not adhere when washed. The oxychloride of antimony proved a good anti-flammable, and withstood the action of water, but not that of soap and soda. The borate and phosphate of protoxide of tin acted effectually when precipitated in the fibre by ammonia from acid solutions. They withstood washing, but tinged the fabrics yellow. So also did arseniate of tin. Stannates of lime and zinc protected the fabric, but would not withstand soap and soda. Oxides of tin could be permanently fixed, but gave a yellow tinge, and so were only suitable for coarse substances, such as canvas, sail-cloth, &c. It was found, however, that sail-cloth treated with this salt lost in strength, and increased greatly in weight. The conclusion arrived at was that there was little hope that anti-flammable agents could ever be fixed in fabrics without injury thereto. The final conclusion arrived at advocated the adoption of sulphate of ammonia, and of tungstate of soda in manufactories of light fabrics, and in laundries.

Applications of the Soluble Alkaline Silicates.

In 1859, Professor Abel reported to the War-office on the above subject. A portion of his report dealt with the application of silicates to the protection of wood and fabrics from fire. When a piece of wood, thinly coated with the silicate, is exposed to high temperature, or to contact with flame, the wood emits inflammable vapour which catches fire, but the glazing prevents the solid portion of the wood burning. As soon as the coated wood is removed from the heat, the gases will no longer be evolved, and the flame ceases. In 1854, Mr. Abel instituted experiments with soluble glass, with a view of discovering a method of protecting wooden camp-huts from fire. It was found that a thin coating of silicate afforded considerable protection, but this was diminished by the effect of air and weather on the boards. Successful results were, however, obtained by applying limewash over a coating of silicate, and a second coating of silicate over the lime. The hard coating thus obtained resisted rain, and did not exhibit any tendency to crack, shrink, or detach itself from the wood. In 1856, satisfactory experiments were carried out upon a hut thus prepared. The cost of covering wood with the protective material was about 2d. for a surface of ten square feet; at the date of the report, (1859), it was reduced to half that sum. The following were the difficulties to be met in treating canvas or other similar fabrics :—

1. The protective materials render the fabric very rigid and harsh.

2. The substances employed have a tendency to absorb moisture; and, therefore, to keep the fabric in a very damp condition, an effect which, although promoting the efficacy of the agent, is very inconvenient in many instances.

3. The application is, or soon becomes detrimental to the strength and durability of the fabric.

4. The materials are of such a nature as to be readily detached from the surface, or to be rubbed or shaken out of the cloth.

5. They are soluble in water; and, therefore, their application must be renewed whenever the fabric has been exposed to wet.

In the case of finer fabrics which require washing, No. 5 would not be of very great importance, inasmuch as the treatment by one of the numerous saline compounds proposed could be repeated. The problem of protecting canvas, such as is used for sails and tents, had been for the first time satisfactory solved by Messrs. Versmann and Oppenheim, who introduced into the canvas a compound of tin so permanently fixed that washing did not remove it. The strength of the fabric was not affected [but see statement at the end of Versmann and Oppenheim paper. The canvas, when exposed to heat, or or flame, behaved just like a piece of wood prepared with soluble glass. The only important objections were the great increase in weight, and the costliness of the agent employed. In consequence of this costliness, Professor Abel had undertaken some experiments with soluble glass. Simple saturation with an alkaline silicate afforded efficient but temporary protection. Great difficulties were found in attempts to fix the silicate in the canvas by combination with metallic oxides, but at last a successful method was discovered of inducing the formation of an insoluble silicate within the fibre, the canvas being thoroughly saturated with the soluble glass, and a second agent [the name of which is not given] before the separation of the new silicate in the insoluble form occurred. The protection afforded was stated by Professor Abel to be thoroughly and permanently effective, while the cost of the material would be very considerably below that of the tin compounds used in the before-mentioned method. An appendix to the report gives an account of the experiments, at Chatham, on huts coated with silicate of soda and lime-washed; also directions for covering timber with protecting solutions of silicate and lime.

TWENTY-SECOND ORDINARY MEETING.

Wednesday, May 23rd, 1883; The Hon. EDWARD LYULPH STANLEY, M.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Alley, Stephen, 15, Royal-crescent, Crosshill, Glasgow.
Barber, Edward, 88, Fishergate-hill, Preston, Lancashire.
Bayliss, George Reginald, Spondon, Derbyshire.
Brewer, William John, 79, Queen-st., Cheapside, E.C.
Browning, George Frederick, The Châlet, Kingswood-road, Dulwich-wood-park, S.E.
Connor, John Wreghitt, 23, Park-row, Leeds.
Croft, James A., Ashley, Putney, S.W.
De Ricci, James H., Meadowbank, Twickenham.
Elles, Colonel William K., C.B. 34, Victoria-road, Kensington, W.
Fischer, Carl August, St. David's, Saltney, near Chester.
Fletcher, George, Poplar Iron Works, Poplar, E.
Fyers, Lieut.-General William Augustus, 19, Onslow-gardens, S.W.
Gerner, Capt. Henry, 47, Talbot-rd., Bayswater, W.
Hedley, Ernest Hall, Gelly-gron, Pontardawe, Swansea.
Horsfield, William Joseph, Falcon-road, Clapham-junction, S.W.
Malcolm, William Rolle, 1, Hereford-gardens, Park-lane, W., and 59, Strand, W.C.
Mills, Frederick Charles, 106, Jermyn-street, S.W.
Morrish, T. Buxton, Leonard-house, Upper Tulse-hill, S.W., and 5, Regent-street, Pall-mall, S.W.
O'Gorman Mahon, Colonel James (*The O'Gorman Mahon*) M.A., M.P., Ennis, Co. Clare, Ireland, and House of Commons, S.W.
Steel, Major-General James Anthony, 28, Stafford-terrace, Kensington, W., and East India United Service Club, S.W.
Wade-Browne, Captain Edward P., 28, Ashburne-place, South Kensington, S.W.
Wavish, James 34, Hamfrith-road, Romford-road, Stratford, E.

The following candidates were ballotted for and duly elected members of the Society:—

Broadbent, John James, Stafford-house, Burney-street, Greenwich, S.E.
Dobson, George, Llanishen, near Cardiff.
Watson, William, Derwent-hill, Keswick.

The paper read was—

TECHNICAL INSTRUCTION IN ELEMENTARY AND INTERMEDIATE SCHOOLS.

By PHILIP MAGNUS, B.Sc., B.A.
Director and Secretary of the City and Guilds Institute for the Advancement of Technical Education.

One of the many points that strike the observer in comparing foreign schemes of education with our own, is the more systematic gradation of schools abroad, showing the several stages through which a youth passes

on his way from the primary school to the university, or corresponding technical institution. In England, owing mainly to the large number of private schools—whose aims and objects are not, in all cases, well defined—and also to the influence of class distinctions, our schools overlap one another to a very great extent, and it is difficult to classify them according to any simple educational principle. As our technical schools are new, and are likely to become every day, to a greater extent, the schools of the people, it is desirable that they should be so organised as to constitute a compact hierarchy, forming a graduated series from the lowest to the highest; and there would be a certain advantage and simplicity if they could be known and designated as schools of the 2nd, 3rd, or 4th grade, beginning with the primary schools as the lowest.

The City and Guilds of London Institute for the Advancement of Technical Education has had in view the completion of such a series, in the schools which have been established under its direction; and recognising the well-known fact that the higher grades of education stand more in need of adequate endowment than the lower, the Institute has directed its efforts, in the first place, towards the establishment of schools of the 3rd and 4th grades, represented, in its scheme, by the Finsbury College, which has recently been opened, and by the Central Institution, now in course of erection. In this graduated series, one important school, or class of schools, is still wanting; and the consideration of this want, and how to supply it, will form the main subject of the present paper.

In describing the seven ages of man, our great poet gave one only to school life—

> "At first, the infant,
> Mewling and puking in the nurse's arms;
> Then the whining schoolboy, with his satchel
> And shining morning face, creeping like snail
> Unwillingly to school."

Judging from these lines, I think we may conclude that Shakespeare had probably no conception of infant education, and that he had little experience of the value of educational method in making a child's school-days pleasurable instead of painful. But a closer analysis of the period of school-life shows that it really consists of five stages, represented by the infant school, or Kindergarten, and the elementary school, both of which may be said to be common to the education of all children; and then on the technical side, by the intermediate technical school, the technical college or professional school, and the technical university. The necessity for the addition of this technical side to our educational system is due mainly to the rapid growth of our manufacturing and engineering trades, which have opened up occupations and careers that did not exist a century ago. The old grammar school education has been found to be no longer the best training for persons who are to be engaged in these different occupations. Every day it is becoming more generally recognised that education must have some reference to the career or future work of the person educated, and that schools are needed which shall be as well adapted to the present requirements of productive industry, as were the grammar schools of old to the several kinds of professional life, in which alone educated persons were then engaged. In former times, the few people who received more than an elementary education, were instructed in those special subjects which would prove serviceable to them in the pursuit of their special callings. The priest studied Hebrew and Greek; the lawyer, Latin and logic; the statesman, history and rhetoric; and the rest of mankind who received any school education whatever, were content with the power of reading, writing, and reckoning. Those who were employed in any kind of skilled labour learned their trade from the masters to whom they were apprenticed. Instruction of this kind had a direct bearing upon the career of the person who received it; and, to this extent, the education of all these classes of persons might be called technical; although it is customary, in this country, to restrict the meaning of that word to education bearing directly upon productive industries. Granting that all education should have for its object the preparation of a man for the real work of life, what we have now to consider is the kind of education which shall best fit the children of the labouring and lower middle classes of the population for the several occupations in which they will be engaged, and which shall, at the same time, afford facilities for the selection of the brightest and most capable of such children for higher training.

I. The problem of primary education is somewhat simplified in this country, owing to the fact that the public elementary schools are attended almost exclusively by persons who cannot afford to pay the full cost of their children's tuition. These schools are, therefore, essentially the schools of our working

classes, the schools in which labourers, artisans, and persons occupying humble positions in commerce and trade receive their first, and, in most cases, their only training. Although primary instruction is the basis of all education, and is necessarily very much the same, whether the pupils be the children of working men or of their employers, still there are differences in the methods of instructing children who will have to begin to earn their living at the age of twelve or thirteen, and of those who will continue their education until the age of sixteen or seventeen, or possibly later, which render it easier in this country than either in Germany or Switzerland, to adapt the instruction given in our primary schools to the specific wants of the class of pupils receiving it. Apart altogether from the question of social distinctions, which in Italy, America, and other countries does not prevent the son of the doorkeeper from receiving his instruction side by side with that of the master of the house, these educational considerations are likely to continue to induce well-to-do parents in this country to attach importance to the provision of separate elementary instruction for their children, either in the lower forms of secondary schools, or in preparatory schools leading up to them.

In this country we have not yet had time to realise the full benefit of the Education Act of 1870; but there is little doubt that this Act, amended as it has been by subsequent codes, has done much, if not everything, towards the solution of the problem of primary instruction for the masses. The most earnest advocates, however, of the last Revised Code would probably be willing to admit that there is no finality even in revised codes, and that additions and improvements are still possible.

On every occasion on which I have had the opportunity of speaking on this subject, I have called attention to the neglect of drawing in many of our public elementary schools, which is the more to be regretted, seeing that the majority of the children trained in these schools are destined to commence life in occupations in which the ability to draw is quite as useful to them as the ability to spell. I am inclined to think that it is partly in consequence of the examination and inspection of drawing being placed under a different department of State from that which superintends the general work of elementary schools, that this subject, important as it is, comes to be regarded as an extra rather than as an essential element in primary instruction. Adequately satisfactory results are not likely to be obtained until drawing shall have been made an obligatory subject, both in girls' schools and in boys' schools, subject to the same rules of examination and inspection as reading, writing, and arithemetic.

There is another subject of instruction, which, having regard to the future occupations of the pupils, ought, in the opinion of many educational authorities, to be introduced into public elementary schools, viz., instruction in the use of the more ordinary tools found in every workshop. The advocates of this proposal do not desire that lessons in handicraft work should occupy any part of the time that is now devoted to other subjects of instruction, neither do they suggest that such teaching should take the place of apprenticeship to any trade, nor do they expect even that it would sensibly diminish the period of such apprenticeship. They look to the disciplinary rather than to the directly useful influence of such teaching, and they recognise in it many distinct advantages. Following on the Kindergarten system of handicraft exercise, this instruction would help still further to train the hand to the perception of differences of size, form, roughness, and other qualities, which the sense of touch, guided by the muscular sense and sight, enable us to appreciate; and in this way it would serve as a real discipline and as a sense exercise. Morally, it would teach children, at an early age, that there is nothing derogatory in hand-work. On the contrary, by making workshop teaching a part of the school instruction, the pupil would be trained to recognise the dignity of labour, and would come to understand that it is as honourable to earn one's living by the use of the file as of the pen. M. Jules Ferry, in laying the foundation-stone of a French school one day this month, is reported to have said:—

> "Caste ideas would vanish when tools were found in schools alongside of maps and books, the nobleness of manual labour would be perceived, and concord would be spread."

Whether the effect of the introduction of workshops into schools would be to "root out anarchist passions," as M. Ferry is further reported to have stated, I am unable to say, but certainly it would tend to draft into manufacturing industries a number of youths who, at present, seek employment in commercial or badly-paid literary work, and who can be much better spared from the office-desk than

from the workshop bench. In the schools of our manufacturing cities it is, perhaps, more important that this kind of manual exercise should find a place than in those of the great centres of commerce. Although it is quite true that, in these towns, the majority of the pupils from the elementary schools will be engaged in handicraft work during the whole, or the greater part of, their life, and that, therefore, it is well to employ such time as they can give to education in purely intellectual pursuits, there are compensatory advantages in training the child's hand and eye at an early age which should not be lost sight of. For apart from the social considerations to which I have referred, the nimbleness of finger thus acquired is likely to save the boy, on entering the factory or mill, where he is at once told off to some work requiring quickness of manipulation, from much of the weariness and drudgery of the first few months of his apprenticeship, and to make him permanently a better workman.

In considering the question of the introduction of handicraft work into our public elementary schools, we always have the example of the French schools to fall back upon. As nearly everybody now knows, the experiment has been tried for some years in the Communal School of the Rue Tournefort, Paris. When this school was first established, the boys commenced handicraft work at the age of ten; but since the beginning of the year 1881, children of six years of age have received instruction during three hours a-week in the use of tools. In the highest class of this school, the pupils, besides receiving instruction in drawing, chemistry, and in science, work eighteen hours a-week in the shops. During the last year, the work of the pupil is specialised in certain directions, so that the school partakes of the character of a trade school. The hours are from eight in the morning till six in the evening, with a half-holiday on Thursday. It has been thought that the amount of time devoted in this school to workshop instruction interferes with the purely literary education of the pupils, and, consequently, this school has not been made the type of others that have recently been established in Paris and elsewhere. In accordance with the Laws of December, 1880, and of July, 1881, handicraft work has now been introduced as an optional subject into most of the communal schools of Paris. Both Chambers of the French Assembly are agreed that primary instruction should include manual work, and the use of the tools of particular trades.

When the Commissioners on Technical Instruction visited Paris in 1881, there were twenty-three primary schools to which workshops had been attached, ten others were on the point of being opened, and preparations were being made to attach workshops to twelve more. Since then I have ascertained that forty-one schools are fitted with workshops, and it is the intention of the authorities to attach them to all the communal schools of Paris. The manual instruction in these schools begins only at the age of ten years.

Brussels has followed the example of Paris. In the primary State schools recently erected, and constructed very much on the pattern of the Ecole Modèle, now converted into a training and practising school, workshops have also been introduced. In a mixed school I visited, some few months since, situated in the Rue du Canal, the girls were instructed in various kinds of needlework, whilst the boys of the upper classes learned modelling, drawing, carpentry, turning, and smiths' work, devoting about four hours a week to workshop instruction. The school provides for over 1,000 pupils; about forty of whom were engaged in practical work at the date of our visit. The workshops were very small, or the numbers would probably have been larger, but all the boys pass through the shops before leaving the school. Judging from the character of the general literary instruction which we had the opportunity of inspecting, I should say that the time devoted to this work had not in any way interfered with the teaching of the ordinary school subjects. Neither in Germany, in Switzerland, nor in Italy, is workshop instruction given in the elementary schools; but in these three countries the public elementary schools are by no means as exclusively frequented by the children of the working classes as they are in England, France, and Belgium. Whilst generally in favour of the introduction of some kind of handicraft work into our elementary schools, I think it very desirable that the instruction should not be commenced at too early an age. To children below the Fourth Standard, I do not believe it would be of any practical use. It is important, moreover, that the main object of such instruction should be kept steadily in view, viz., the discipline and exercise of hand and eye, without reference to the requirements of any particular trade. There can be little doubt that so much skill as a boy would acquire in handi-

craft work during the last year or two of his attendance at an elementary school, would be useful to him in any and every occupation in which he might be subsequently engaged. I dwell upon the fact that the instruction should be without reference to special industries; because, viewed in this light, I see no reason which should prevent the Government from including handicraft work among the list of specific subjects on which grants are made. Indeed, I can find no difference in principle between paying grants on needlework in girls' schools, and on handicraft work in boys' schools. It is possible that the girl may become a sempstress, and the boy a carpenter; in either of which cases, the instruction may be regarded as trade instruction. But the lessons need not be given with any special object, but merely as a part of the general education of the child. The case of manual work in boys' schools seems to me to be exactly parallel with, and in every way analogous to, that of needlework in girls' schools; and I am inclined to think that the value of the one kind of teaching should be as fully recognised and assisted by the State as that of the other.

II. As soon as we ascend one step higher on the educational ladder, the tendency to specialise instruction, with the view to the future occupation of the pupil, commences. The bifurcation or the "trifurcation" of studies, if we may use the word, takes place according to the social position of the parents, or according to the probable career of the pupil. This tendency to give a bias or direction to the studies of a child commences in the higher elementary and middle class, or preparatory, schools; *i.e.*, in the education of a boy between the ages of thirteen or sixteen. Speaking generally, and it is difficult to be definite or specific without going into very great detail, boys who are intended to pursue a university career, or to enter the legal, the clerical, or the scholastic professions, learn both Latin and Greek; those entering a profession, such as medicine, in which some acquaintance with science is necessary, learn Latin, but no Greek; and those who expect to become mechanical engineers, foremen of industrial works, superior artisans — the majority of whom go to work with the knowledge and aptitudes they take away with them from schools of a grade higher than the elementary—should have the opportunity of omitting from their instruction both Latin and Greek, and of giving their attention to practical science and modern languages. It is this last class of intermediate schools which is at present wanting in our educational system. Of preparatory schools adapted to the wants of rich men's sons, who will carry on their education in our great public schools, there is no lack. Those who frequent them can afford to pay for the instruction they require, and their wants are well supplied. Of middle schools, leading to our new first grade modern schools, or to the modern side of our classical schools, there is also no great need. Nearly all the new grammar schools, whose schemes of instruction have been drawn up by the Endowed Schools Commissioners, fall within this category; and with the view to remedy any deficiency in the number of such schools, in towns where no endowment exists which can be utilised for this purpose, a public company has recently been started, which I hope may meet with all success, to supply additional schools of this type. But of schools adapted to the requirements of children of the artisan classes—schools into which the picked pupils from the elementary schools might be admitted, and where they would receive an education which would train them as intelligent workmen or clerks—there exist at present only a few isolated examples; and considering that the classes of persons for whose benefit they are needed are not able to pay for them, nor likely to agitate for their establishment, the want which is so seriously felt, impeding, as it does, the progress and due development of technical education in this country, will probably remain, unless the State, or the municipalities, or wealthy individuals, interested in the progress of education, voluntarily aid in their foundation.

In Ireland, where new industries have to be created, the want of technical instruction in the primary and intermediate schools is more keenly felt than in England or Scotland; and it is possible, if technical instruction is to be introduced into Irish schools, that it may have to be more specialised than would be necessary or desirable in this country. This subject in all its bearings is now receiving the careful consideration of the Commissioners, and although it is impossible to forecast the measure of the success they may achieve, I think I may say that they are fully aware of the pressing importance of this question, and will spare neither time nor thought in endeavouring to arrive at some satisfactory conclusions.

It may be interesting, however, here to mention that a committee appointed by the

Municipal Council of Dublin, to consider the question of technical education in Ireland, have issued a report, in which they state —

"We conceive that education in Ireland is on too exclusive a literary basis. We believe that, from the earliest years, the training of the hand, the eye, and the mind, whether by the Kinder-garten system or otherwise, should be made a matter of primary importance. We think that all alike should be taught drawing, as the best preparation for almost any avocation. . . . In the principal towns throughout the country, schools should be more completely equipped for instruction in the industries suitable to the particular locality. . . . We consider that the advantages offered by examinations, under the London Guild Schools' scheme, should be immediately availed of by committees of manufacturers, without prejudice to the ultimate establishment of a similar scheme for Ireland on an independent basis."

A correspondent, too, who takes great interest in this matter, writes to me from Dublin, saying—

"I venture again to beg of you to endeavour to call attention to the general absence, in all classes, of training other than literary. Drawing is universally neglected; mathematics and arithmetic do not receive the attention they should."

Without entering further into this question of Irish education, I pass to the consideration of the problem that has been engaging of late the attention of the School Boards of London, and of other cities, viz., the establishment of so-called higher elementary schools. In London and elsewhere, there exist a number of middle-class schools, which are intended to give a complete education to children belonging to the lower middle-class, and which, as regards their educational rank, are intermediate between the secondary and the elementary schools. As preparatory to the modern side of our great public schools, these establishments may serve a useful purpose; but as offering a complete and useful training to the children of the better class of artisans, foremen, and small shopkeepers, who have to earn their living in manufacturing or commercial pursuits, they fail of their object. Their curriculum is a compromise, resulting from the conflict of too many studies. They break down between their aspirations and their necessities. Whilst endeavouring, to some extent, to adapt the instruction to the wants of the pupils, they cling with obstinate fondness to the traditions of the past, and, consequently, their curriculum is overcrowded, and nothing is well taught. It would seem that there is something of gentility, presumably attractive to the middle-classes, in the study of Greek, which induces the authorities to place this subject in the prospectus of these schools. For the time devoted to this study is far too short to enable a boy to derive any real benefit from it, unless it be the doubtful advantage of making him suppose that he understands the meaning and connotation of a scientific term when he has learnt its derivation. Latin is generally regarded as indispensable, not so much on account of its utility, for a boy seldom opens a Latin book after leaving school, nor for the mental discipline it affords, because that might be acquired through a modern language, or, indeed, through any other study, but in order that the pupils may pass the Oxford and Cambridge Local Examinations. It is true that there are a few boys in these schools who aspire to be surgeons, or to enter the medical profession, and for these an elementary knowledge of Latin may be necessary as a part of their professional training. Then, again, mathematics are frequently taught, as if the boy would spend his life in solving enigmas; and geometry is made a discipline in logic, the study of which leaves the pupil with a thorough distaste for the subject, and with no practical knowledge which he can apply to the simplest problems he will meet with in his ordinary work. In deference to public opinion, the boy is taught in many of these schools, but not in all, what is called science, and studies chemistry and physics from books, or by aid of lectures, accompanied by blackboard, or, in some cases, table illustrations, which pass for experiments. He learns a certain amount of French grammar, can translate a piece of simple French prose into English, but can neither speak nor understand, when spoken, two simple sentences. Of German he is generally absolutely ignorant. In many of these schools drawing is still taught from copies of landscapes, or elaborately shaded heads; and in scarcely any is there any approach to what may be called practical instruction. It may be thought that I am exaggerating the defects of the majority of our intermediate schools, but it is not so. For many years past, I have had opportunities of making myself acquainted with the education given in these schools, and the experience I have thus gained, confirmed as it has been by recent experience, has led me to conclude that the curriculum of these schools must be greatly modified, if they are to give to the children of our middle classes a rational and serviceable education.

We often hear an outcry raised against the over-education of the so-called working classes. We are told that the higher instruction contemplated by the School Board is calculated to make children of the labouring class dissatisfied with their lot, and unfit for the work which they will be required to perform; that education takes the artisan out of his proper sphere, and leads him to plot, or starve in another sphere which is already occupied by active workers. Some of us are apt to think lightly of this expression of fear, and to ascribe it to the alarm of despairing pessimists; but I am compelled to admit that, where the education is exclusively or to a great extent literary, there is some foundation for it. It cannot be denied that the higher education which the majority of our middle-class schools provide, tends to weaken the association of the artisan with his work, and to lift him out of his sphere, instead of enabling him, as it should do, better to understand and discharge his duties within it. If, however, the education of our intermediate schools were such as to develop the boy's faculties in a practical direction, to give him the knowledge and the skill that would be serviceable to him in productive industry, such knowledge as he would always desire to increase, and such skill as he would be always endeavouring to perfect, then the outcry against this over-education would be meaningless and needless.

It is to be regretted that, owing to the absence of good intermediate schools, in which the education provided might serve as a fit preparatory training for the subsequent work of the superior artisan, some of the best boys of the elementary schools of London have been taken out of the sphere in which their talents and skill are so much needed, and transferred to other occupations, and, possibly, to the overcrowded ranks of professional life. The few scholarships which the School Board of London possesses, are mainly employed in drafting the most promising pupils from these schools to the higher secondary schools leading to the Universities.

Mr. E. N. Buxton, in his opening address to the members of the School Board, on October 12th, 1882, referred to this disposition of the selected children from elementary schools. In remarking on the paucity of the scholarships at the disposal of the School Board of London, viz.:—103 in all, many of which are provided by the City Companies, he said:—

"It may interest the Board, as indicating the class from which these children are taken, to know that their parents follow respectively the occupation of school teacher, chemist, glazier, dressmaker, clerk, compositor, blacksmith, and decorator.

"The scholarships range in value from £16 10s. to £40 per annum, and enable the successful scholars, after leaving the elementary schools, to continue their education for some years longer in one of the higher schools, such as the City of London School, or the North London Collegiate School for Girls, whence, if they maintain their early promise, the door is open to them, by means of further scholarships and exhibitions, to the Universities . . . Some scholars have already passed with remarkable distinction through all these grades."

Now, see what follows from this absence of good intermediate schools into which these promising students might have been drafted. Schools like the City of London School, University College School, and King's College School, all of which have received pupils from the elementary schools, by means of these scholarships, do not, and are not intended to, provide the education which is specially adapted to the wants and requirements of our artisan classes. In the Universities, as at present constituted, the curriculum of studies, and the general associations, are not such as to render these ancient seats of learning the best training schools for the would-be engineer, the industrial chemist, the manager of a factory or mill. It has not been possible for me to trace the careers of the boys from the elementary schools who, during the last eight or nine years, have been thus educated; but it is more than probable that, owing to the absence of good intermediate schools, and of technical colleges, such as that now established in Finsbury, these boys have been trained to some professional or literary calling, by which productive and manufacturing industry has lost the acquisition of intellect it so much needs, and the lack of which has gone far to deprive us of our commercial supremacy. Mr. Buxton goes on to say, "It would be nothing less than national waste to restrain these children from the full exercise of their powers;" but I very much doubt whether the nation gains much by sending these children into the already overcrowded paths that are open to university students.

In considering the kind of instruction of which our artisan population stands in need, we must first of all cut ourself adrift from the traditions of the old grammar school system, and endeavour to establish some relation

between the education of the child and the career in which he is likely to be engaged. We may take it for granted that, in the curriculum of these schools, there is neither room nor necessity for the study of Latin or Greek. The children of these schools must be educated, as were the Athenians of old, without the advantage of knowing any dead language. The vernacular proved sufficient, even as mental discipline, for the education of Phidias and Archimedes, and I see no reason why it should be found wanting in the training of their modern prototypes. The backbone of the instruction to be given in these schools should be mathematics. Of mathematics a boy cannot well know too much. It is applicable at all stages of his work, in the solution of the most elementary and of the highest practical problems, and without this necessary knowledge, the pupil's progress is continually impeded. But mathematics should be taught with a view to the possibility of their application; and for this reason, Euclid should be banished from the school, or confined to the instruction of the highest classes. The next subject of importance is science, and the branches of science most generally taught, viz., chemistry, mechanics, and physics, should be chiefly encouraged. The science teaching should be made the chief instrument for the exercise and development of the reasoning and observing faculties. It should be given more with this object than for the sake of the information imparted; and, consequently, the success of such teaching should be judged, not so much by the extent of the pupil's acquirements, as by the thoroughness of his insight into the principles and methods by which scientific laws have been established. It always seems to me that it is owing to the absence of the discipline of science teaching in our principal schools, that the experienced schoolmaster, feeling the necessity of some equivalent for stimulating observation, attention, comparison, and reasoning among his pupils, has been compelled to apply the methods of science to the teaching of classics, and has therefore attached less importance to the linguistic skill acquired by his scholars than to the mental discipline which the study has afforded. But although Latin or Greek may thus be made the instrument of scientific teaching, the study of these languages can never do the same for us as the study of any one branch of natural or physical science, because, as has been often said, science brings us face to face with real objects, things in themselves, and language tells us only about words. Mr. Matthew Arnold agrees with Wolf, and I think rightly so, in saying—

"That all learning is scientific which is systematically laid out and followed up to its original sources, and that a genuine humanism is scientific."*

Scientific it is, but it is not science; and the argument of the humanists in education seems to me to be faulty in this, that they think that the teaching of scientific method in reasoning about words is an adequate substitute for the teaching of science in observing and reasoning about things.

It is superfluous to say that all intermediate schools should be provided with a laboratory, in which the pupils may receive practical instruction in chemistry. Too much importance, however, should not be attached to the students' ability to analyse a simple salt. Although qualitative analysis may be made the instrument of sound teaching, it may also degenerate into little more than a rule of thumb process—the mere carrying out of definite instructions. The value of this practical work depends upon the method of teaching adopted, upon the care with which the pupil is taught to observe, and the logical accuracy with which he is trained to reason upon the observations he has made. In physics and mechanics, the pupil should be exercised to a greater extent than is as yet common in practical work. The experiments to be performed by the pupil may be of the simplest and roughest kind, but they should have for their object the teaching of the methods of observation, which will be invaluable to the workmen, when thrown among the more complex phenomena of after life.

What I have said about drawing in elementary schools applies equally to intermediate schools. The pupils should have the opportunity of further pursuing their instruction in this subject, so that they may be able to discover any latent talent they may possess for art work, and so to determine for themselves their own careers. But in addition to drawing, modelling in clay should form a part of the art instruction of these schools. Modelling may be taught, and successfully taught, to very young children. It forms part of the curriculum of the Tournefort School, to which I have already referred. Abroad, the number of technical schools in which this subject is taught is very large. To nearly every art industry it is considered an indispensable

* *Nineteenth Century*, August, 1882, p. 220.

preliminary training—to metal work of all kinds, pottery, wood-carving, &c. The educational value of this instruction is, no doubt, considerable. In many of the arts in which boys are likely to be engaged, facility in modelling, as showing the power of appreciating and realising solid forms, is found to be of the utmost service. Indeed, instruction in modelling constitutes a kind of supplement to that of drawing, and may well be pursued at the same time by the young pupil training for art industries. In learning drawing, the pupil generally commences by copying from the flat to the flat, then from the solid to the flat, and lastly, in rearranging materials previously studied, and in original design. In the teaching of modelling, the opposite course is followed; the pupil begins by imitating in relief what he sees in relief, and then proceeds to copy in relief what is presented to him in the flat; and lastly, by aid of mere sketches and suggestions, or original conceptions, to project into the solid form the pictures of his mind.

It is important that the humanistic elements of education should not be omitted from the curriculum of these schools. It is in the combination of literary with scientific and practical instruction that many foreign schools are so superior to our own. Language and literature may be regarded as indispensable requisites of all higher education. Indeed, I believe the educational value of knowing another language than our own is fully equal to the use it may be to us in enabling us to speak it or to write it. Words occupy in our minds a different meaning, and bear a different relation to the things for which they stand, when we know that the same thing may be expressed by more names than one. For this reason, and also on account of the undeniable and increasing utility, in commerce and in industrial pursuits generally, of a knowledge of modern languages, I would include both French and German in the course of instruction to be given in such schools. Of the importance of a good English education I have no time, nor is it indeed necessary, that I should now speak. I have no desire to enter here into the vexed questions, which rightly engage the attention of educationalists, as to the relative advantanges of different methods of teaching. Questions of detail of this kind are properly considered in societies exclusively devoted to the discussion of educational problems. We may take it for granted that these subjects should be taught in our new intermediate schools. But of the value of the study of literature in the future education of artisans, I venture to say one word, because I believe that, apart from the pleasure afforded to the pupil by the power to appreciate the writings of great men, and apart from the humanising and elevating influence which the love of good literature is calculated to exercise on the man's life, there is no subject which serves so well to stimulate and develop his imagination, to fill his mind with good impulses and high ideals, and so to exercise a beneficial influence upon his modes of thinking, his habits, and his works.

Thus far, the course of study I have suggested would be common to all pupils of these schools. But beyond this point, in all large schools, particularly in great commercial cities, such as London, Liverpool, Birmingham, and Manchester, the principle of bifurcation might be introduced, with a view of giving to the school a commercial as well as a technical character. Every one knows how difficult it is at present, in spite of the overstocked state of the market, to obtain good clerks, and how frequently it happens that foreign clerks, especially Germans, succeed in commercial houses where our own fail. That this is mainly owing to the want of adequate education, there can be little doubt. Boys who have opportunities of entering commercial houses, or who show a special aptitude for writing, arithmetic, and language, should receive special instruction in these schools in handwriting, book-keeping, shorthand, commercial arithmetic, and French and German correspondence; whilst the pupils on the technical side—those who expect to earn their living by the use of their hands—and in all our great manufacturing centres these would constitute the larger class—should have workshop instructions and lessons in machine drawing. The practical work to be done in the shops attached to these schools should be more exact, and altogether of a higher grade than that done in the elementary schools, where the instruction would be restricted to the mere handling and use of tools. It should give the boy some really valuable constructive skill, and would form a fitting preliminary to his apprenticeship, the term of which might certainly be thereby diminished. This practical instruction would vary very much according to the district in which the school was situated. In our commercial cities and great manufacturing towns, the instruction

would be of a general character, consisting largely of wood work and of metal work at the bench, at the lathe, and at the forge. To a boy going afterwards into an engineer's shop, such instruction would doubtless be of considerable utility; but equally in almost every other industry this practical training would enable him to learn, with much greater rapidity, the details of his trade. Many of the most useful improvements in machines have been made by workmen, after a succession of trials and errors. A large manufacturer, who had himself been a working man, told me, very recently, that this had been the case with most of the improvements that had been introduced into the complicated machinery used in lace manufacture; and there can be little doubt that such improvements might be more frequently effected, if select workmen received at school the practical education I have suggested.

It is, however, in the education of foremen that such schools are likely to prove of the greatest benefit. In consequence of the extreme subdivision of labour, which often condemns a man for the greater part of his life to the same task, it is becoming more and more difficult, in certain industries, to select competent foremen from the general body of workmen. We are often told that the foreman, like the poet, *nascitur non fit*; that he is chosen not so much for his superior knowledge or skill as for his innate power of influencing others, for his tact, and other qualities which mark him out for a position of command. But other things being the same, the better-educated workman, who had been trained in such a practical school as I have described, and who, as a boy, had been selected for such training in consequence of his superior intelligence and skill, would have advantages over his fellow-workpeople which would bring him to the front, and render him more capable and efficient than the man who is scarcely in any way superior to those whom he directs.

As I have already stated, the special work that will be done in the shops attached to these schools would depend very much upon the locality of the school. In rural districts, it might be found advisable to substitute practical agriculture for workshop instruction. Where a new industry has to be created, the teaching might be specialised with the view to a particular trade. In manufacturing towns, it might be advantageous to give the pupils, by way of object lessons, some elementary ideas of the technology of the raw product, be it wood, iron, cotton, or wool, the manufacture of which may form the staple industry of the place. In girls' schools the time set apart for work in the shops might be devoted to dressmaking, cooking, china painting, and other occupations. But the consideration of this part of the question would take me far beyond the limits which I have prescribed for myself in this paper.

The last point I have to consider is how this higher education may be best established and maintained, and this leads me to touch upon the practical question of fees. Intermediate schools, such as I have described, ought to be placed within the reach of the better class of artisans, of foremen of works, small manufacturers, and small shopkeepers. The fees ought to be such as persons in what is called the lower middle-class of society could afford to pay. They should not be so high as to place the instruction beyond the reach of such people, nor so low as to give to the education a too distinctly eleemosynary character. Considering the prevailing feeling in this country, that persons able to pay for the education of their children should not avail themselves of the instruction given in the public elementary schools, most of these intermediate schools of which I am speaking might have a junior department attached to them, for the children of parents capable of paying fees in excess of the maximum fee chargeable by the School Board. If intermediate education were under the direction of the State, there would be no difficulty in the establishment of such schools; but as School Boards throughout the country are unable to earn grants, and at the same time to make a higher charge than 9d. a week, a difficulty does present itself. For the education given in these schools would be largely sought after by parents willing and able to pay higher fees, and it would be in opposition to the best interests of the school to exclude this class of children from its benefits. The admixture of the poorer, but in some cases more gifted, children of public elementary schools with other children having a higher standard of living, and occupying a somewhat better position in the social scale, would tend to improve both classes of pupils, and would give a good tone to the school work.

In what way the means may be found for the establishment of these schools without State aid, I am not prepared to say. There still exist endowments originally intended to provide elementary education for poor children,

which are no longer needed, and which might be utilised in this direction. Public enterprise, aided by public and private generosity, might step in and help to set such schools afloat, as has been done in the case of the high schools for girls, and more recently in the case of the middle schools for boys. I am not without hopes that the Boys' Day School Company may consider the provision of these technical intermediate schools to come within the sphere of its intended operations. Such schools are certainly more wanted, and I believe they might be made a more profitable investment, than the ordinary Latin school. Again, numbers of existing schools might adapt their curriculum to the requirements of the industrial classes, and help to fill up this great lacuna in our educational system. But if no endowments can be found available, if public enterprise will afford no aid, and if existing schools continue to cling to the traditions of the past, then I think it will become necessary for the School Boards to provide suitable instruction for the selected children of the public elementary schools; and if, as certainly will happen, the children of a somewhat wealthier class avail themselves of this State-aided teaching, it seems to me that it is better, far better, that a few persons who can afford to pay should accept eleemosynary instruction, than that hundreds and thousands of promising children should go without it. But both on moral and on social grounds, and for the assistance that would be thus afforded in the maintenance of these schools, I cannot help thinking that it would be well if the maximum school fees in these higher elementary schools could be raised from 3s. to 6s. or 8s. per month. It may be said that I have grouped together, without distinction, higher elementary and middle-class schools. I have done so because I can see no reason, beyond one resting on very insufficient social grounds, to separate them. Such schools might be made to serve for those who can, and cannot, afford to pay for their own education. The School Board might be empowered to pay part or the whole of the fees of the deserving children drafted by competition into the higher schools; and, in certain cases, the most needy of the children should receive scholarships to help towards their maintenance, and to compensate their parents for the loss of their children's early earnings. The expenses of the maintenance of the schools would be in part defrayed by the grants obtained from the Science and Art Department, and by those of the Education Department on specific subjects; and if the funds at the disposal of the City and Guilds of London Institute were sufficient to enable the Council to give assistance to such schools, it is very possible that they might be willing to pay on the results of the examinations of the manual work done by boys preparing for apprenticeship, much in the same way as they now pay on the results of the examinations of apprentices and workmen in different branches of technology.

From what I have said, it will be seen that I am inclined to agree with those persons who consider that this higher instruction should be given in separate schools, into which the selected pupils of the ordinary elementary schools would be drafted. It must be remembered that the necessary teaching appliances in intermediate schools such as I have described are somewhat costly, but that, when they are adequately provided, they serve for the education of a larger number of children than are likely to be able to avail themselves of such advanced instruction in any one school. Moreover, I think it a waste of national strength to over-educate, at the country's expense, the dullards of a school. There must be hewers of wood and drawers of water to the end of time. What we have to see to is that, whilst we send out into the world, adequately equipped with knowledge, the rank and file of our children, to occupy the lower rungs of the great industrial ladder, we lose no opportunity of selecting the children of special aptitudes and brighter intellects, and of training them for higher posts, so that there may not be lost to the industry and commerce of our country, which so greatly needs their aid, a spark of genius nor a stroke of skill.

III. Of schools giving an education somewhat on the lines I have suggested, there are already a few good examples in Great Britain. Of these, one of the most sucessful, perhaps, and certainly one of the most recent, is the upper department of the Central School at Sheffield. Mr. Cole, Chairman of the Sheffield School Board, in his report, says:—

> "In this higher department, our general aim is not to lift our young people out of their own sphere, but to lay that foundation for the intelligent future pursuit of technical knowledge and skill, which will enable them so to deal with the difficulties of their trade, that they may compete successfully with every similar class of workmen in any part of the world."

This school is situated in a central part of Sheffield, and children are admitted into it, at

about 12 years of age, by competitive examination from a few private schools, and from the Fifth Standard of the public elementary schools. Mr. Moss, clerk of the Sheffield School Board, who has devoted much time and thought to the consideration of this subject, informs me that, last year, only 3 per cent. of the children examined by the Government inspectors for England and Wales, were presented in the Sixth Standard, 8 per cent. in the Fifth Standard, and 16 per cent. in the Fourth Standard. It is for the selected children from this small per-centage, numerically large, of the total number of children educated at the public expense, that intermediate technical and commercial schools are needed.

The curriculum of instruction in the Central School, Sheffield, comprises geometry, mathematics, chemistry (theoretical and practical), and physics; freehand, model, geometrical, and machine drawing; handicraft work, consisting of exercises in the production of simple but perfect geometrical forms in iron and wood; and the construction of models, and of simple physical apparatus for use in the school itself. Specimens of the boys' work have been kindly forwarded to me by Mr. Moss, for the inspection of persons who are interested in seeing the kind of work that can be done by school boys devoting to it only a few hours a week. The models here exhibited are in all cases made from working drawings prepared by the pupils themselves.

It is proposed to introduce into the school curriculum modelling, and more advanced art work for the higher education of pupils showing special aptitude in this direction. The workshops have been fitted up by the liberality of the manufacturers of Sheffield; but the school feels the want of some external authority to test the work done by the boys, and to assist the Board, by means of grants on examination, in meeting the expenses which this special instruction involves. It appears from the table in the next column, taken from the last Report, November, 1882, of the Sheffield School Board, that in the year 1882, 335 candidates were examined for admisssion into the Central School; that of these, 172 passed, and were admitted, and that of this number, 165 were candidates from the Fifth Standard of the public elementary schools, and seven from the private schools of the town.

Another school, of a somewhat higher grade, giving workshop instruction, is the Allan Glen's Institution in the City of Glasgow. This school owes much to the energy and high organising

SHEFFIELD CENTRAL SCHOOLS.—ENTRANCE EXAMINATIONS.

	Minimum Standard to be passed.	Total No. examined.	No. who passed and were received.	No. who failed.	Of the No. who passed, there came from.	
					Public Elementary Schools.	Private Schools.
1880 ...	4th Stand.	587	305	282	289	16
1881 ...	5th ,,	403	196	207	183	13
1882 ...	5th ,,	335	172	163	165	7
		1,325	673	652	637	36

No. on books during month ending September, 1882 312
Average attendance during same period 284

powers of its head master, Mr. E. M. Dixon, who himself has visited some of the principal technical schools of Europe. The school contains an elementary, a secondary, and a technical department. In the secondary department the instruction consists largely of mathematics, drawing, and science, and it serves as a preparation for the higher school. The technical department has a two years' course, in the first of which the studies are common to all the pupils, whilst in the second, they are specialised, according as the pupil intends to devote himself to engineering or to chemistry. Those who stay long enough pass three years in the school workshops. In the first year, they have two and a half hours' workshop instruction per week, in the second three hours, and in the third year five hours.

The fees vary from £3 to £6 a year in the secondary school, while they are as much as £8 8s. per year for the complete course in the technical department. Nearly all the pupils of the technical department of this school come from the public elementary schools of Glasgow, which, throughout Scotland, are frequented by rich and poor alike to a much greater extent than is the case in South Britain. I am informed that the practical skill gained by these pupils, devoting during three years not more than half-a-day per week to workshop instruction, is fully equivalent to that which they would acquire in the first two years of their apprenticeship to an engineer.

There are a few schools in other parts of the kingdom, notably in Keighley, Nottingham, Manchester, and Perth, which approach more or less nearly to the type of school to which which reference has been made in this paper.

Abroad, the best specimens of intermediate schools, combining technical and secondary education, are those in France. By a law recently passed, the education in the higher elementary schools, the curriculum of which includes classes of professional instruction, have been made free, and these schools rank as public primary schools.

By reference to the First Report of the Commissioners on Technical Instruction, it will be seen that—

"Besides the ordinary elementary schools, there are, in most of the large towns, superior elementary schools (*écoles primaires compleméntaires*) for literary, and, in some cases, technical instruction. The cost of instruction in these schools, when it is not free to all, is very cheap, from 7 francs to 10 francs per month, and even these low fees are, in the case of the non-gratuitous schools, either partially or wholly remitted to many pupils by means of scholarships (*bourses*) granted by the State, the departments, and the communes. The entrance is obtained by a non-competitive qualifying examination, or on presentation of the *certificat d'études primaires*, to which we allude later. Some of these schools provide workshop instruction adapted to the wants of the industries of the districts in which they are situated. We have not been able to obtain recent statistics of these schools, but they are increasing rapidly in number, though they are still confined to the larger towns."

According to a notice that appeared recently in the *Times*,* these schools have increased, since 1879, from 20 to 400.

Of such schools, one of the oldest and one of the best is the Ecole La Martinière, at Lyons. This school is situated in the centre of a great weaving and dyeing district, and the courses of instruction, besides including wood and iron work, modelling, mechanics, physics and chemistry, are specialised in the second and third years, to give the pupils an opportunity of knowing something about chemistry in its application to dyeing, the mechanism of the loom, and the theory of weaving. A description of this school, and of many other similar institutions, including the Ecole Turgot of Paris, the Ecole Primaire Complémentaire of Rheims, one of the most recent and best of the higher elementary schools of France, and the Ecole Professionelle of Rouen, will be found in the second report of the Commissioners, which it is hoped will be issued during the present year.

In their preliminary report, from which I have already quoted, frequent reference is made to the higher elementary schools of France, of which little appears to be yet known in this country. On pr 25 will be found a notice of a report of M. Tolain, president of a commission appointed by the Minister of Public Instruction, in which he recommends the establishment of "a series of graded schools consisting of a *salle d'asile* and Kinder-garten; an ordinary primary school, in which manual work is taught; and a superior primary school of a somewhat advanced character, including technical instruction, and extended over a three years' course."

In Italy, Germany, and elsewhere, similar schools are found, in which preliminary instruction is continued, and connected more or less with specialised practical work But I must not anticipate the contents of the Commissioners' second Report. Even now, I must ask you to accept the suggestions I have made as my own, and not necessarily those of my colleagues on the Commission. Indeed, I felt some hesitation in responding to the invitation of your Secretary, to read a paper on a subject which really forms a part of the investigations entrusted to the Commissioners; but, knowing how prominently this question has been brought under public notice, and how important it is that this great want in our educational system should be speedily supplied, I have assumed the responsibility of giving my own conclusions, as fetched from the experience I have acquired of the working of foreign schools, and of the want of similar institutions at home.

One word more. A short time since, when speaking at the opening of the Finsbury Technical College, I remarked that the wave that is now pushing forward technical education would not subside until schools of every grade had felt its influence. Judging from a notice in the report issued by the Commissioners of Education in the United States, the new impulse seems to have affected the schools of America in much the same way as I expect it will before long influence our own. The report states:—

"The multiplication and growth of schools of science has been a marked feature in the recent history of education in America. Either the stimulus given to them by the national aid, or the sentiment which compelled Congress to give help to higher education, has carried forward and deepened the interest in industrial, scientific, and technical instruction. Students are now more frequently choosing lines of study which lead to a life of business, activity, or to prominent positions in industrial pursuits. Colleges

May 3, 1883.

that a few years since held strictly to a rigid classical course are feeling the new impulse, and are striving to add to their efficiency, by making provision for special instruction preparatory to definite occupations. Men of wealth are endowing schools of science and technology more richly than other institutions; for they believe that the practical education which has now come to the front will do more than anything else to promote the industry and prosperity of individuals, and to utilise the resources of nations." *

If men of wealth in every town in England would lend a helping hand to the establishment of intermediate or second grade technical schools, to supply the missing link between our primary schools and the technical colleges or trade schools, many of which are now being erected in different parts of the kingdom, the difficulties to which I have referred would be quickly removed, and England might have reason to be proud of possessing as complete and well-organised a system of technical education as can be found in any country in the world.

DISCUSSION.

Mr. Moss, clerk to the School Board for Sheffield. said it was gratifying to hear from the lips of one of the Royal Commissioners of the advance which had been made in liberality of opinion on the subject of technical education. The experiment which had been made in Sheffield was somewhat novel, but they had every reason to be gratified with the success which had attended it. It was modest in its dimensions, but definite in its aims, and it could not vie in importance with the Allan Glen Institute, at Glasgow. He almost envied the work of Mr. Dixon in his school, and the meeting would, no doubt, hear a great deal from him with regard to the application of technical knowledge to the special industries to which attention had been given in that school. During ten years, he had spent considerable time in visiting Continental schools, and he had found that whereas in Germany and Austria technical education was given to pupils who could stay at schools until they were seventeen or eighteen, no attempt was made to bring it within the reach of the artisan classes. The Ecole Turgot, at Paris, appeared to be the best example of such a school for English teachers to follow, for the benefit especially of the artisan classes. There were there children drawn from the public elementary schools of Paris, and he had been surprised at the work he saw done. He thought it was within the province of the constituted educational authorities to do that kind of work in the great towns in England. In Sheffield, they had only attempted to give workshop instruction to the higher classes in their central school, but they had found it very difficult to crowd more subjects into the curriculum forced upon them by the School Board. Boys there learned something of practical geometry, and began to make in the workshop correct geometrical forms, and the specimens before the meeting, produced by boys of twelve to fourteen, were the result of instruction given in the geometrical drawing class in connection with the use of tools. He hoped the pupils so taught would be able to go forth to such institutions as the Allen Glen College in Glasgow, and continue their instruction there to a much more advanced stage. The Sheffield Central School had succeeded in obtaining from the City Guilds Institute a grant for the establishment of a school for engineers, and the pupils who could take advantage of the scheme would get the benefit of as grand an educational system as any town could boast of. With regard to a remark that the instruction was not required to be special he had had to conduct, some weeks ago, a number of working men connected with trade associations, and, after going through the workshop and chemical laboratory, they all expressed a very strong opinion that whatever might be the trade or employment to which a boy might afterwards be put, he would there get a most valuable preparation for it, and they wished that it could be placed within the reach of every working man's child. Although the teaching might not bear directly on the trade to which a boy might afterwards be put, it would have a most important bearing on his career. It was exceedingly important that whatever trade a boy was intended to pursue, he should have some knowledge of the use of tools imparted to him, and the power of putting on paper ideas which others might be enabled to carry out and improve upon.

Mr. E. M. Dixon would confine his remarks to the school at Glasgow, which he represented. That school had been divided into three departments—elementary, secondary, and purely technical. By elementary, they meant the education a lad usually received until he had passed the Fifth Standard of the common Board school. The first class in the secondary department corresponded roughly with the Sixth Standard, but went considerably beyond it in mathematics and drawing. In that class no very earnest effort was made to teach science proper though a little experimental science, as far a principles went, was taught, with the view of preparing for the following classes. They carried the boys' education four years beyond what the common Board school did, and in the first year of the extra period they commenced in earnest the teaching of science. Then followed chemistry, physics, solid geometry, and hitherto physiology but he was afraid that the study of physiology would have to be discontinued, and that they would have to confine themselves more to subjects bearing upon chemical and engineering matters. Up to this time, the teaching of English

* Extracted from notice of report in *Nature*, May 10th, 1883.

had been going on side by side with these scientific studies. In the highest class of the secondary department, the boys were introduced to the laboratory and the workshop. The object in this was not so much to train the scholars in manual dexterity as to make their studies more real to them. Though dexterity was of course acquired, the important point was to make their instruction in technical drawing and applied mechanics more a real to them. In the purely technical department they dropped the study of English altogether, and merely carried on, in the way of languages, the study of French and German. They had been anxious to carry out the ideas of the Science and Art Department in the third year, but as they dealt with somewhat different subjects, a difficulty had arisen. He had taken the opinions of experienced engineers and chemists as to whether it was advisable that the young engineer should drop his studies in chemistry, and the future chemist his mechanics, and the unanimous opinion given was that the pupils' studies should be carried further than what the Science and Art Department called the elementary stage. Accordingly, the boys were all allowed to go on with their engineering and chemical studies until the last year, when they had to take a side, some pursuing chemical, and others mechanical studies, in the workshop and laboratory. It was intended to add metallurgy to the chemistry, a very important branch of science in which chemists were finding employment. Those remarks would convey a general idea of the method of teaching adopted in the school; and to show the results from it, he had sent up for examination by those present specimens of the work done by the boys in wood and metal, and a number of their drawings from models. Some of these were evidently the work of mere beginners, while others were of very superior execution. The lads of course started with no manual dexterity whatever, but they went on working in the shop for three years. In the first year they were only there two-and-a-half hours in the week, and to avoid their cutting up the wood, they were supplied with uselessly, they were charged for it, and allowed to take home the simple articles they were able to make, such as the knife-boxes, writing-desks, and tool-chests exhibited. After the first year, they were able to make models which were of use in the school, drawing them first on paper, and then working to scale from the drawings. One set of drawings in the room had been made from the lathe used in the workshop. The result was that the boys became well acquainted with mechanical drawing. The school was only in its fifth year, but the boys who had passed completely through the course of teaching had proved their superiority over other lads who had been working at their trades for a considerable time. Notwithstanding, he thought it inadvisable to shorten the period of apprenticeship, as it took a long time to make a thoroughly skilled engineer, and five years was not too much, even with the teaching afforded in the school.

Mr. E. C. Robins, a member of the Council of the City Institute, said Mr. Magnus had presented an excellent *résumé* of the whole subject, from the infant school to the University, in connexion with technical education, the true meaning of which was to teach more about things themselves than could be conveyed by mere language; words represented the thought in their minds, but the things which the words represented were more important, not only for artisans to understand, but for the professional men who designed for them. The knowledge of principles gained in the workshop went far beyond mere book learning, and he hoped the system referred to by Mr. Magnus would be largely carried out, and the sooner they could get it introduced by the School Board into elementary education, the better for them all.

Mr. D. Walker, Practical Instructor in the Technical Classes at King's College, said the time and attention which Mr. Magnus had given to these subjects was well known. For 15 years he had himself been foreman in large factories, and had numbers of apprentices in his charge. He found that the general education of the youths had a great influence on their success in learning their trade. For the last ten years he had been training men in the higher classes of mechanical work, and had found good results from the teaching. Hardly any comparison could be made between those who learned in that way and the ordinary workmen in manipulative skill, as the former were far in advance of the others. Mr. Magnus had sketched out a curriculum which had been advocated by many professors. In Leeds, where students entered works to pass through the ordinary articled pupils' career, their time had in this way been, in some cases, reduced. He did not agree with beginning work of this kind too early, and he thought there was not much gained by boys commencing it before they were 13 years old. There was a possibility of going too far in that direction, looking at their experience from the Continent.

The Rev. Mr. Pearson, member of the School Board for Hackney, said they had many practical evidences of the interest which this subject was beginning to excite among the public. Scholars should be taught to use their hands with dexterity, and the system of giving object lessons should be further extended. He had brought the subject forward at the School Board, though unsuccessfully, but he was glad to say Dr. Gladstone had taken it up, and a committee had been appointed to consider it. He hoped they would have the assistance of Mr. Magnus, Professor Silvanus Thompson, Mr. H. Trueman Wood, and other gentlemen like them, who would help in this excellent work. Such knowledge, if given to men—and particularly to women—would vastly increase their happiness. He regretted that no lady members of the School Board were

present, as they would no doubt have supplied the omission, so far as the discussion of the subject, that the technical education of women had not been dealt with.

The CHAIRMAN referred to the importance of the subject to the industrial activity of England, as well as to the literary and professional classes who would be benefited by it. He could not help feeling, however, that there was great difficulty in introducing much technical teaching in the way of handicrafts into our schools as they were at present organised. The time at teachers' disposal was so limited, and the curriculum of subjects under the Code so extensive, that it would be difficult to find an opportunity to teach what might be called handicraft. In France, though the hours of study were longer, handicraft instruction had to be given to the boys before the ordinary school studies commenced, and after they were over; and it seemed impossible, therefore, that it could be given in England without a very material extension of school hours. But he heartily agreed with Mr. Magnus in the necessity for model drawing being made the ground work for technical instruction in schools. Another subject greatly required was mathematics, which should be taught instead of physiology and other subjects which teachers were so fond of taking. They were rendered almost useless in consequence of actual demonstration being prohibited by the Code—a model might be used, but a sheep's eye or bullock's heart could not be brought for dissection, to show what the things taught really were. Teachers should be instructed to teach mathematics, both geometry and algebra. Some people would have technical schools mainly schools of science, and others advocated the exclusive teaching of manual dexterity. He was not competent to say which was the better method, but his inclination was rather to side with Mr. Dixon in saying that, up to the age of 16, the object should rather be to give the boys a groundwork of practical knowledge. At Oldham, where the science school had been mainly founded and supported by Messrs. Platt Brothers, who took a great interest in the industrial education of the people, Mr. Platt had told him they would rather their apprentices came to them without any practical knowledge, so that they might learn from the beginning, without having to correct wrong ideas which they might have got from a somewhat smattering kind of teaching. Some fifteen or twenty years ago, at the works in the north of England, German chemists were usually found, but now the gradual growth of scientific teaching in England had resulted in English chemists being more generally employed. No doubt great progress had been made in the last few years in practical scientific teaching. Of course the School Board should endeavour to carry out these objects, but they were not so free to do what they desired as people supposed, and they did not yet dare to build in London proper drawing class-rooms, where the pupils could be taught to draw from models. In all London they had not been able to establish one laboratory where the boys, or even the teachers, could receive practical instruction in chemistry. Those places were required, and ought to be provided, but the London ratepayers would not furnish the means.

Mr. MOSS desired to add that it had not been found possible in their school to give the technical instruction required within the ordinary school hours, but the boys willingly came earlier to receive it.

Mr. MAGNUS said he had not entered specially into the subject of primary education, as he more particularly wanted to see the "missing link" established in our system of education, into which pupils from the primary schools could be drafted. The subject of technical instruction to women was too large a one to be dealt with satisfactorily as a mere section of his paper. Abroad, schools existed where such instruction was given to girls combined with the ordinary education. It was at that hour too late to enter upon the vexed question of the opinions of manufacturers, as to the value of handicraft teaching in schools which boys might bring into their workshops; but he hoped that the results of the experiments which had been made would lead all to the same conclusion on the subject as he had arrived at in his paper.

The CHAIRMAN added that the only technical instruction, strictly speaking, which the London School Board was giving to women, was in the art of cookery.

The meeting concluded with votes of thanks to the author of the paper.

Miscellaneous.

BLACK FOREST CERAMICS.

Consul Catlin, of Stuttgart, states in his last report that a large trade in the manufacture of porcelain and pottery is carried on at Schramberg, a town in the south-western portion of Wurtemburg, which is reached by rail to Oberndoof, and thence by coach over mountain roads. It is a town of about 5,000 inhabitants, and manufactures, in the course of a year, enough wooden clocks and straw hats to supply the two million inhabitants of Wurtemburg, enough household crockery to replenish dealers' stocks throughout the whole of Germany; and porcelain and majolica ware sufficient, not only in quantity, but also in quality, to invest the industry with the importance and character of a national one. The factory was first established in 1820, but long prior to that time potters had made use of the clay deposits which exist in that neighbourhood and elsewhere throughout the kingdom. At first, only ordinary pottery

and glazed stoneware were manufactured, and these goods were sold in large quantities throughout Southern Germany and Austria. In 1856, the manufacture of white, coloured, and gilded porcelain was commenced, and has been followed with success up to the present time. The manufacture of majolica ware has of late been taken up, and the goods produced have not only great artistic merit, but command a ready sale in nearly every part of the world. The factory annually uses about 60,000 pounds of kaolin, which is obtained from Carlsbad, in Bohemia; 20,000 lbs. of feldspar are also imported every year from Bergen, in Norway, at a cost of five shillings per hundred pounds. From Coblentz there is also annually brought to Schramberg 400,000 pounds of clay used in making earthenware and majolica, costing two shillings per hundred pounds. Besides these imported materials, there are used yearly 800,000 pounds of slate clay from the quarries at Schramberg itself, and 3,200,000 pounds of a thin clay found at the neighbouring village of Waldmoessingen; thus it will be seen that a total of about 2,240 tons of clay and other crude materials are every year transformed at Schramberg into finished wares. Besides the 3,000 tons of coal used, 282,528 cubic feet of wood are also annually consumed. The establishment has ten ovens, with a capacity of 16,245 cubic feet, and eight smaller furnaces for burning in the colours and gilding; each time one of the latter is lighted it consumes 883 cubic feet of wood fuel, while in heating the larger ovens seven tons of coal are used in the case of porcelain, or twelve tons if earthenware is to be baked for the first time. The second baking of earthenware requiring a lesser degree of heat, involves only a consumption of four tons of coal. The Schramberg factory employs about 350 persons; ordinary workmen are paid from 2s. to 3s. a day; women and boys, from 9d. to 1s. 6d.; and girls, an average of 1s. each. The best decorators receive about 5s. a day. The models used in the majolicas embrace many of the Renaissance as well as modern styles, and also goods with ivory glazing, decorated in the Persian style. In conclusion, Consul Catlin states that the Schramberg pottery is shipped, in greater or less quantities, to the United States, to South America, to every country in Europe, and to such remote points as the Cape of Good Hope, Algiers, and Australia. At both the Melbourne and Sydney Exhibitions diplomas were awarded to this industry.

EXHIBITION OF HEMP-PREPARING MACHINES AT BOLOGNA.

The Agricultural Society of Bologna has organised an International Exhibition of Machines for preparing hemp in the country. The rewards include a single prize of 4,000 lire (£160) for a new cleaning machine, which will, alone, effect the entire removal of the fibre from the macerated hemp. There are certain special requirements to be complied with as to the working capacity of the machine, and the cost of preparing hemp by its means. Other prizes will also be given. If none of the objects sent in are deemed worthy of the higher prizes, the amounts will be divided into smaller rewards.

Applications for space should reach the Agricultural Committee at Bologna (Italy) before June 30th, and should be accompanied by an exact description of the machine which it is proposed to send. The machines have to be delivered by August 10th, at latest. The Exhibition will last from the 18th to the 25th of that month.

AERONAUTICAL EXHIBITION, PARIS.

An exhibition of everything that relates to ballooning is announced to be held in the Trocadero Palace, Paris, from 5th to 15th June next, to celebrate the centenary of the invention of balloons. It will comprise—

(1.) Raw materials used in the construction of balloons, such as silk, cotton, rope, nets, cane, &c.

(2.) Gas balloons, captive or steering, montgolfiers and separate parts used in the construction or working of balloons.

(3.) Parachutes, kites, and mechanical birds.

(4.) Books, MSS., plans, photos, drawings, and models relating to aeronautics.

(5.) Instruments for use in aeronautic meteorology, such as barometers, thermometers, hygrometers, registering appliances, and photographic apparatus.

(6.) Apparatus for making pure hydrogen, carburetted hydrogen, and carburetted air.

(7.) Light motors, gas and petroleum engines.

(8.) Electrical apparatus, susceptible of being utilised in aeronautics, such as motors, telegraphs, telephones, and electric lamps.

(9.) Appliances for aerial correspondence, by optical telegraphy, or by carrier pigeons.

No charge is made for space; but exhibitors must arrange their exhibits at their own expense. Applications to be made to the office of the journal, *Aéronaute*, 95 Rue Lafayette, Paris.

The number of inventors in France who are now turning their attention to this science is considerable; including M. Tissandier, with his elongated balloon and electrical motor; M. Brisson, with his navigable aërial vessel; M. Tissot, with his aerostatic bird; M. Cayrol, with his winged balloon; and M. Pompeien. with his elongated balloon.

General Notes.

Turin Exhibition.—A special section at the Italian General Exhibition, to be held at Turin in April, 1884, will be devoted to electricity, and exhibitors of all nations will be allowed to compete

for prizes. Telegraphs, telephones, measuring instruments, batteries, accumulators and apparatus for electric lighting will be fully exhibited, as well as instruments connected with the various applications of electricity to the transmission of signals, to the firing of mines, to medicine and surgery, &c.

LOUISVILLE EXHIBITION.—Further information respecting this Exhibition (see *ante*, p. 667) has been received from the Foreign Office, through the Science and Art Department. The contents will be arranged in twenty-five groups and five departments. Department 1, will be devoted to natural products (mineral, vegetable, and animal); Department 2, to machinery and tools; Department 3, to manufactures; Department 4, to transportation (animal-power, wind-power, steam-power, and electric-power); Department 4, to music, literature, and art (musical instruments, books, stationery, painting, printing, scientific instruments, and models, &c.).

MEETINGS OF THE SOCIETY.

Wednesday evenings at Eight o'clock:—

MAY 30.—"The Relative Claims of Etching and Engraving to Rank as Fine Arts." By F. SEYMOUR HADEN, F.R.C.S. Sir RUTHERFORD ALCOCK, K.C.B., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evening at Eight o'clock:—

MAY 29.—"Queensland: its Progress and Resources." By ARTHUR J. STANESBY. W. MCCULLAGH TORRENS, M.P., will preside.

INDIAN SECTION.

Friday evening at Eight o'clock:—

MAY 25.—"Some Notes on the Domestic Architecture of India." By C. PURDON CLARKE. Sir GEORGE BIRDWOOD, M.D., C.S.I., will preside.

CANTOR LECTURES.

Monday evening at Eight o'clock:—

The Fifth Course, on "Secondary Batteries." By Prof. OLIVER J. LODGE, M.A., D.Sc.

LECTURE II.—MAY 28.

Uses of the secondary battery in practice; laboratory purposes; motive power; action as a regulator; transmission of energy; lighting by means of water-power; locomotion on land; marine locomotion; efficiency of motors driven by batteries.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. O. J. Lodge, "Secondary Batteries and the Electrical Storage of Power." (Lecture II.)

Institute of Surveyors, 12, Great George-street, S.W., 3 p.m. Annual General Meeting.

Royal Geographical, University of London, Burlington-gardens, W., 2 p.m. Annual General Meeting.

British Architects, 9, Conduit-street, W., 8 p.m. Mr. C. Fowler, "The Cistercian Abbey of Maubronn, Würtemburg."

TUESDAY, MAY 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. Arthur J. Stanesby, "Queensland: Its Progress and Resources."

Royal Institution, Albemarle-street, W., 3 p.m. Professor McKendrick, "Physiological Discovery." (Lecture IX.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on the following Papers:—1. Mr. Alexander Leslie, "The Edinburgh Waterworks." 2. Mr. John George Gamble, "The Waterworks of Port Elizabeth, South Africa." 3. Mr. John Addy, "The Water Supply of Peterborough."

Science Society, King's College, Strand, W.C., 8 p.m. Mr. G. G. Hodgson, "The Relation of Insects to Plants."

WEDNESDAY, MAY 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. F. Seymour Haden, "The Relative Claims of Etching and Engraving to Rank with the Fine Arts."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. The President's Conversazione at the South Kensington Museum.

THURSDAY, MAY 31...SOCIETY OF ARTS, John-street, Adelphi, W.C., 3 p.m. Public Meeting to consider the Question of Fires in Theatres. The Report of the Society's Committee on that subject will be presented for discussion.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Third Conversazione.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. S. Poole, "Recent Discoveries in Chaldæa and Assyria."

Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

East India Association, the Lower-hall, Exeter-hall, Strand, W.C., 2½ p.m. Miss Florence Nightingale, "The Dumb shall Speak, and the Deaf shall Hear; or, the Ryot, the Zemindar, and the Government."

FRIDAY, JUNE 1...Royal United Service Institute, Whitehall-yard, 3 p.m. Mr. B. F. S. Baden-Powell, "Military Ballooning."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. F. Pollock, "The Sword."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m.

SATURDAY, JUNE 2...Royal Institution, Albemarle-street, W., 3 p.m. Professor Turner, "Russian Social Life." (Lecture III.)

Journal of the Society of Arts.

No. 1,593. Vol. XXXII.

FRIDAY, JUNE 1, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXAMINATIONS, 1883.

The list of successful candidates in the examination for the present year has been issued, and is forwarded to the Institutions in Union with the present number of the *Journal*. Copies for the successful candidates will also be sent to the various Local Boards.

CANTOR LECTURES.

The second and last lecture of the course on "Secondary Batteries and the Electrical Storage of Power," was delivered on Monday evening, 28th inst., by Professor OLIVER LODGE, M.A., D.Sc. The lecturer described the uses of the secondary batteries in practice, and dealt with the questions of lighting by means of water power, of locomotion on land, of marine locomotion, and of the efficiency of motors driven by batteries.

The Chairman (Mr. W. H. PREECE, F.R.S., Member of Council) moved a cordial vote of thanks to Professor Lodge for his valuable and instructive course of lectures, which was carried unanimously.

The lectures will be printed in the *Journal* during the autumn recess.

PREVENTION OF FIRES.

A public meeting was held yesterday afternoon (May 31), to consider the question of the prevention of fires in theatres. Sir WILLIAM SIEMENS, D.C.L., F.R.S., Chairman of the Council, in the chair.

A report of the proceedings will be printed in next week's *Journal*.

CONVERSAZIONE.

The Society's Annual Conversazione will be held this year in the Buildings of the International Fisheries Exhibition. His Royal Highness the Prince of Wales, President of the Society, has intimated his intention to be present.

The precise date will be announced, when it is fixed by H.R.H. the President, and cards of invitation will then be issued to the members of the Society. Each member will as usual, receive a card for himself and a lady.

Proceedings of the Society.

TWENTY-THIRD ORDINARY MEETING.

Wednesday, May 30th, 1883; Sir RUTHERFORD ALCOCK, K.C.B., in the chair.

The following candidates were proposed for election as members of the Society:—

Farnan, Francis, 16, Tredegar-place, Bow, E.
Fitch, William Bowers, New Cross Glass Works, Glenville-grove, Mornington-road, Deptford, S.E.
Mond, Ludwig, F.C.S., Winnington-hall, Northwich.
Reed, Charles Holloway, J.P., Trimdon Iron Works, Sunderland.
Sykes, Frank James, 20, Fitzroy-square, W.
Sykes, Harry Tatton, 280, Regent-street, W.
Sykes, Mrs. Mary Eflat, 20, Fitzroy-square, W.

The following candidates were ballotted for and duly elected members of the Society:—

Harwood, John, J.P., Woodsleigh, near Bolton.
Ross, O. C. Dalhousie, Little Bookham, Leatherhead.

The CHAIRMAN, in introducing Mr. Seymour Haden, remarked on the great importance and interest of the subject he was about to bring forward, and on which he was so eminent an authority. Those who could possess the works of the great masters, whether old or modern, must always be very few, but a fine reproduction of a great picture, by engraving, was infinitely more satisfactory to a cultivated taste than any second-rate copied picture. This boon we owed to engraving, and etching was a branch of engraving in which Mr. Haden had achieved great distinction, and

it had always been a peculiar merit. Etching—which at one time seemed going out of date, but he hoped Mr. Haden had done something towards reviving the admiration for it which existed in the days of Rembrandt—possessed a freedom and crispness which you could not obtain in any other form of engraving. You had the very touch of the artist, whereas the engraver must necessarily copy.

The paper read was—

THE RELATIVE CLAIMS OF ETCHING AND ENGRAVING TO RANK AS FINE ARTS.

By F. Seymour Haden, F.R.C.S.

It is to be understood, for the purposes of the present short paper, that all forms of engraving on metal, whether by the etching needle, the burin, by mezzotint, or aquatint, or by whatever other form the artist may choose as a means of original expression, are to be considered as included in the common term etching; and that like forms, when not used for the purposes of original expression, are to be understood as included in the common term "engraving."

Thus it will be seen, that the object of the paper is not to contrast etching, as a process, with engraving as a process, the etched line with the engraved line, and to say of one that it is better as a form of art expression than the other; and certainly not, in any sense that can be considered in the least personal, to exalt one class of artist at the expense of another; but to compare, without regard to the process employed, or the person employing it, the practice of the painter etcher, who is an original artist, with that of the modern engraver, who is not an original artist, and, by the discussion which I hope will follow such comparison, to arrive at an intelligible conclusion as to the comparative claims of the two to be considered "fine art."

Nor can such an inquiry be considered any longer as, in any sense, either impertinent or unnecessary, since etching, though an original art with a great history, is without representation in the Royal Academy; while engraving, which is not an original art, is fully represented there; and since without such representation (such is the influence, for good or for evil, which attaches to the action of the Royal Academy, and such the irresponsible power vested in that body), that no art, however legitimate, can live among us, and no artist, however meritorious, thrive. I think it proper to say, at once, that it is an object of this paper, not merely to suggest an interesting inquiry, but to test the reasonableness of this position.

Before such a comparison can be made, however, it is obvious that a consensus of opinion must first be established, as to the nature of the conditions which constitute an art; and as to the principles which regulate and control such conditions; and also, as to the nature of those special conditions which elevate an art, properly so-called, to the rank and dignity of a fine art.

It would be difficult, perhaps, to find any word of the same dimensions which, in its various applications, covers so much disputable ground, and as to the precise logical value of which so much confusion exists, as this little word "art;" for art in the abstract is not art in the concrete; nor are "art" and "the arts" the same thing; while there is a point at which that which may properly be called an "art," and that which is only an "industry," may well be matter of opinion.

This being so, the shortest and, perhaps, the only way to re-establish the order of ideas, the confusion of which is here recognised, and to determine what art is, is to determine, in the first place, what it is not. Thus, art, it may be advanced, as a negative hypothesis, is not manufacture—is the reverse, that is to say, of manufacture. The "*arts et métiers*" of the French, and the "arts and manufactures" of the English, are statements of the antithesis here implied, and, though neither term is used correctly, since *métier* means mystery or mastery, and is applicable to an art as well as to an industry; and manufacture means something made by the hand, while we understand it as a product of the loom; still, as embodying a well-defined distinction consecrated by usage, the expression, especially in this place, may well be allowed.

In what, then, it may be asked, does an art differ from a manufacture? An art differs from a manufacture in this, that, though it depends on agencies of a material kind for its outward expression, still those agencies, like the brush of the painter, are of a simple kind, and are wholly directed by an impulse which has its seat and centre in the brain of the artist. Invest anyone of those simple agencies—the brush of the painter, the pencil of the designer, the chisel of the sculptor, the needle of the etcher, the knife of the surgeon, the pen of the poet,—invest, I say, anyone of these simple agents with any of the properties o

the machine—render them, that is to say, in any degree automatic, so as to make unnecessary and place in abeyance the brain impulse just spoken of—and you will have, as a result of such agency, not an art but a manufacture. Or, it may be, by a sort of marriage of the two conditions, there may result something which is less than an art and more than a manufacture—that thing of modern birth, in short, which has come to be called an "art manufacture." I see no objection to this term, since, by the infusion of an art element into it, even a tombstone may be made a work of art, as in the time of the Romans, and a *pot au feu*, as in that of the Etruscans.

A principle of an art, again, is that condition, or one of those conditions, which, by common consent, is admitted to be necessary to its healthy existence.

If, therefore, art is the brain impulse which it is here assumed to be, and this reading of it is confirmed by Johnson, when he declares it to be something which is not taught, it clearly follows that the first great fundamental principle of art must be personality—originality; out of which, again, come ideality, invention, sensibility to external impressions of form, colour, and composition, which is a sense of the beautiful, passion, poetry, and whatever else the mind of the artist is capable of. Not that the practice, and even a certain proficiency in special branches of art, suppose the possession, as of necessity, of all these great qualities; one of them, however, I venture to affirm is necessary, and that one is originality.

It is only necessary to apply this principle to the practice of the older and the modern engraver, to determine the essential difference between the two, and, as it happens, this difference is also susceptible of demonstration. If, for the purpose of such demonstration, I take therefore some well-known engraving, some generally accepted example of the perfection of the engraver's art, such, say, as Sharp's engraving of Sir Joshua Reynolds's "Holy Family," and some equally well-known etching, such as Rembrandt's "Three Trees," Durer's "Erasmus," or Vandyck's "Vostermans," and project upon the screen analogous portions of them, so as to contrast, say, the foreground of one with the foreground of the other, the drapery of one with the drapery of the other, the flesh of one with the flesh of the other; such demonstration will, I think, plainly show that, while the etcher, under the influence of brain impulse and in the full exercise of his volition, engraved as he felt, and allowed himself as he did so the utmost latitude and variety of expression; the engraver, animated by no such impulse, and deprived of his volition, has been driven to express himself by signs and formulæ which, as art expressions, have no intelligible meaning. I might, of course, have found, for the purpose of this comparison, modern engravings and modern etchings which would have furnished even a more striking contrast of the difference of practice here referred to; that I have not done so will be at once understood. If, also, I show engravers' work first, it is because—in order that the technical difference between the two may be seen—I must take as a standard of comparison that one of the two with which the greatest number of persons are most familiar, and that one happens to be engraving.

Here, then, for instance, is the engraver's formula for foreground? It is not, as you see, in the least like foreground, or anything which commonly enters into the composition of a natural foreground; and yet it is the pattern—I can think of no other term—which is used for foreground in nine engravings out of ten—I might almost say of nine hundred and ninety-nine out of a thousand. If the engraver had had the least idea of a foreground in his mind, he surely could not have done it; that he did do it, may, I think, be taken as a proof that he had no such idea—in other words, that the mind had no active part in its production. Contrast this, now, with an equal portion of foreground taken from an etching by Rembrandt. It is, indeed, but an indication, yet every stroke of it proves that the ordinary components of a landscape foreground, grasses, rushes, and even flowers, were present to the mind of the artist as he did them; that his intelligence, that is to say, was awake, his sense of beauty excited, and that both were in active use as a means to the end he intended. In the case of the engraver, there is no sign of any such mental activity, and, therefore, as a result, no art.

Here again, is this formula, by which, as a rule, the engraver expresses flesh. It is still more curious. It consists, as you see, of a number of curved lines parallel to each other, and drawn in the sense of the contour of the object which they are intended to represent, each line being broken into short segmental portions of equal length, with a well-defined dot between every two. That object happens to be part of the cheek of the Virgin. The shadow which determines the rotundity of the part, is pro-

duced, you see, not by any attempt at drawing, such as an artist would have used, but simply by a thickening or thinning of the line, and an enlargement or lessening of the dot, as the case may be; while the moderate lights are determined by their sparseness, and the highest by their total omission. Take, now, an etched head by Rembrandt, of himself; the planes of the face, it will be seen, are expressed, not by any sort of formula, but by the same power of simple drawing which distinguishes the rest of the head, while the accuracy of the drawing is vouched for by the fact that it suffers nothing by an enlargement of from one inch, which is the size of the etching, to fifteen feet, or thereabouts. Vandyck, in his own head, and in that of "Vostermans," obtains his end in the same simple fashion, while in the "Pontius" may be seen the vigour and learning of the etcher subdued and corrected—sweetened is the technical term—by the engraver.

Drapery, again, is suggested by lines of unequal thickness, one being very thick, and the next one very thin, in wavy parallelism, and also in the direction of the contour of the folds, the planes being suggested by a few cross strokes here and there; the same pattern as before being in constant use. With the painter-engraver, on the contrary, who in this case happens to be Durer, every fold is a labour of love, and is made out by work which suggests nothing but what it is meant to be. Moreover, the work is like himself—is like Durer, and nobody else.

Engraver's stems, trees, and foliage, are subject to the same observation; whereas the etcher does his best to give not merely the fact but, without being in the least servile, the rugosities of the bark and the whole behaviour of the tree. The example here shown, which is one out of three trees in Rembrandt's etching of that name, is in the original etching exactly an inch and a-half high. Here it is fifteen feet or more, and yet it loses nothing, but rather gains by the enlargement, and this reminds me to say, in deference to an objection that has been taken that the enlargements here shown have not, in every case, been made by the photographer on exactly the same scale, that such exception is without force, the enlargement being simply made that the *technique* of the work may be seen at a distance; unless, indeed, which is true, that the more you see of an unintelligent line the less intelligible it becomes, and the more you see of an intelligent line the more intelligible—in other words, that if the engraver's line, in proportion as it is exaggerated, becomes less and less like the thing it is intended to represent, the etcher's line becomes more so.

Now, I would respectfully submit that this strange departure from all forms of natural representation on the part of the engraver, and his adoption of a set of symbols which he learnt in his apprenticeship, and which he will transmit to his successors, and which in no respect differ from the symbols employed by the heraldic engraver—in which certain lines stand for *gules*, certain others for *argent*, and others for *sable*—can only be explained by the fact that his task is a mechanical one, and that the brain impulse necessary to the exercise of the creative faculty, and therefore of the art faculty, is in abeyance. True, it must not be forgotten, and may in fairness be here objected, that all lines employed in art are but conventional expressions, and, since there is no such thing as a line in nature, that the line of the etcher is as conventional an expression as that of the engraver. Yes; but there is this difference between the two, viz., that the line of one is an intelligent line—an intellectual means to an intellectual end—and that the line of the other is not. And another fact which plainly grows out of this difference in the intellectuality, if I may use such a word, of the two things, and which seriously affects, of course, their relative art value, is that, while the work of the etcher has an identity of its own, so that we recognise at once an etching by Rembrandt, or an etching by Vandyck, one engraving, as a rule, is really very like another. This statement has been vehemently contested, yet it is a statement the accuracy of which any one who possesses half-a-dozen engravings and half-a-dozen original etchings may test for himself; and the exception, moreover, when it is met with, proves the rule, for there are, or, rather, there have been, engravers who have not at all times, and as a matter of course, condescended to this sort of mechanism. Pontius, Bolswert, Vostermans, and the earlier reproductive engravers who followed Vandyck, were of this category, and so, in fact, were Nauteuil, the Drevets, Masson, and the great portrait engravers of the French school. But these men, following, as they did, closely on the heels of the painter, and being not unfrequently called upon to interpret his indications, rather than copy his work, were themselves, to some extent, original artists, and as such, had no need to employ, and in fact instinctively avoided, a *technique* which was not their own.

Yet even of these, it must be said, that when not so engaged, and when engaged in copying—so soon, that is to say, as the act of interpretation ended with them, and that of translation began—they fell into exactly the same mechanism.

The differences which exist between etching and engraving may, therefore, be properly described as of two kinds—differences of principle, and differences of *technique*—and these again may, not inaptly, be described by some such formula as the following:—"Etching, depending on brain impulse, is personal, and, the creative faculty being chiefly engaged in it, invention, sensibility, and the various attributes which make up the sum of genius, belong to it and constitute it an art. Engraving being without personality—except such as may be supposed to be evolved in the act of copying or translating the work of another—originality, and all the attributes which attend the exercise of the creative faculty, are absent from it, and constitute it a *métier*." There is, I submit, no escape from this position.

All forms of engraving, in short, whatever the processes employed in their production, divide themselves, necessarily and naturally, into two kinds, those which are original and those which are not—those which, under the name of painter-engraving, or etching, were practised by the great masters of painting, who were their own engravers, and by means of which we are able to obtain, even in this remote day, work as original as their painting, and at a comparatively moderate cost; and those by which, under the common term of engraving, the design of the painter is reproduced upon the plate by other minds and other hands.

The workers employed in each of these two kinds of engraving are sub-divisible, again, into two distinct groups—(1) the group of painter-engravers, or etchers who flourished with Durer and with Rembrandt—and a class of workers, in the same direction and having the same art aims which has sprung up in this country within the last 30 years; (2) and the group of mechanical engravers which divides itself in like manner into the class of interpreters, and the class of copyists, or as they prefer to be called, translators.

A short notice of each of these is necessary. The importance of the first of these groups, that of the painter-engravers, or etchers of the older school, and which immeasurably transcends that of the other groups, may be measured by their numerical strength and the number of their engraved works; by the great public collections of those works which have been made and are treasured in every museum in Europe; by the extent of the literature which has been devoted to their history and description; and by the keen competition which is excited for their possession when these—as we have seen recently—come into the market. It is an object of the present paper to suggest the claims which, under one or other of these heads, the group has upon the attention of the student.

Some, though but a faint, idea of the *personnel* of this the first of the two groups, that of the painter-engraver group, of the kind of art they practised, of the schools they formed, the countries they inhabited, and of the nature, though not of the number of the works devoted to their description (since the list here given represents but a tithe of them) may be gathered from the diagrams on the walls, the inordinate length of which furnishes again a measurable proof of their importance. Strange as it may appear—and still stranger when it is considered that, taken collectively, the etchings and engravings, the *ensemble* of which is here indicated, represent the whole history of art at the best period of its existence—the study and enjoyment and collection of them belong almost exclusively to the amateur, a person that a distinguished academical friend of mine, with more candour than politeness, thinks ought to be put down. The professional artist of the day (although it was not always so, as the marks of Reynolds and Lawrence on their acqusitions indicate), as a rule, knows little about them, and cares less. For all that, a treasury of knowledge is hidden away in them, a treasury so vast and deep that if, instead of the disjointed collections which with so much labour and so little consecutive arrangement, they now get together from year to year, the Academy would only open its doors to them, and make a winter exhibition of them, they might show us and themselves at a glance the whole story of art. Moreover, seeing what has been done in this direction by the fathers of engraved art, and comparing what they see with what is being done now by the favoured academician engraver, elect of the Academy, who knows but their hearts as well as their eyes might be opened, and their hands even go out to those more original engravers who, for the best part of a generation, have been doing their best to emulate the practice of these their great prototypes, and whom, during the whole of that time, they have been

keeping at arm's length? Quite seriously, I would suggest to the Academy that it could not do better than systematise its exhibitions of the old masters by a comprehensive exhibition of their etched works, because such an exhibition, over and above the inherent interest which it would possess, would furnish an intelligent key to all future exhibitions, just as drawings and models furnish a key to the pictures of which they are the first thought. Nor would they meet with any trouble in making a catalogue of its contents, seeing that such catalogues are ready made to their hands, and without a single mistake of any consequence to disfigure them, while the diagrams on the walls would furnish them with a hint of the order which might usefully be given to such an exhibition.

Turning now to the second class of this group, the class of modern original engravers, the etchers—the pariahs of the Academy—they consist of a number of persons, some of them painters, and some of them artists seeking to make a profession out of original engraving, who, in the belief that a return to that art in its pure forms is still possible, have formed themselves into a society for its promotion. This association, under the name of the Society of Painter-Etchers, and which succeeded the old Etching Club, consists, at present, of about a hundred original engravers, who meet once a year to exhibit their works, observe progress, and comment on the ostracism to which they are being subjected by the Royal Academy. Their idea being that a return to the original form of engraving, as it was practised by the great masters of painting, would be an advantage to art, their wonder is that such an idea should meet with no encouragement in an Academy of Arts. They go even further, and think that they have a right to be represented in such an Academy, and that the present Academy, in excluding them, is not true to its mission. Another peculiarity of the Society is that, unlike the academician-engraver, who employs an assistant to carry his plates up to what is called "a first proof," its members do the whole of their plates themselves—that is to say, prepare them, think them out, execute them, and, not unfrequently even print them, to which end many of them, like the engravers of old, have printing presses in their houses. Finally, they have no connection with any trades' union such as the "Printsellers' Association," do not make or sell, under deceitful stamps and delusive differences of lettering, false proofs, and, on the whole, go to bed at night and get up in the morning with a clear conscience.

The second group—the group of engravers who are not original arists, and whose occupation is to reproduce on their plates the designs of others—divides itself, in like manner, into two classes—the class of the extinct "interpretive" engraver, of whom I shall make special mention presently, and the class of "translator" engraver, of which the academician engraver of the day is the type.

I am not aware that the marked difference in the art *status* of these two classes, and the comparative rank that ought in reason to be assigned to them, has ever—except by the amateur—been observed. That difference, however, is very great. When, by the preaching of Savonarola against luxuries, and by the death of Lorenzo di Medici, painter-engraving, with other of the higher arts, came to an end in Florence, and Mantegna and his school had one by one died out—the class of engraver of which I am now speaking first arose. Of that class, Marc Antonio was the acknowledged head. Practising in Rome, his office was not, like that of the modern engraver, to copy the finished picture of the painter; but, on receiving from him a mere sketch or suggestion of the design he contemplated, to carry out that design, and finish and perfect it on his plate. Imagine the effect of such an order upon an engraver of the present day! Of Raphael, say, who was one of the few painters who did not engrave his own works, coming to him with a pen and ink sketch of the "Massacre of the Innocents," some of the figures mere nude studies, and others of them only more or less clothed, with the request that the finished plate, as we now know it, should be completed to his satisfaction and delivered to him within a given time! Yet, as may be seen by a reference to the diagram, Marc Antonio was by no means the only artist of this class capable of such an *tour de force*, Marc da Ravenna Agostino Veneziano, and others being quite as capable. Here, then, was an engraver, if you please, fit to rank with the painter, and who, though not painter, might yet quite reasonably have aspired to academic distinction, had there been such a thing, and to share with the painter any honours and advantages which the profession of their day had to offer.

There remains to be noticed the translator

engraver of the present day. I have nothing to say to his disparagement. I have had many pleasant relations with him. He has done good work in his time, by reproducing for us, albeit in a terribly mechanical fashion, memoranda of great models which would not otherwise have come down to us. He is a Royal Academician, a dignitary of art, of whom, lest I should be accused of making "an attack on the Royal Academy"—which, by-the-bye, is the stereotyped phrase for the expression of any difference of opinion which a thinking man may honestly have with that high-handed body—I prefer to maintain an absolute silence. Besides, *de mortuis nil nisi bonum*. A mechanical engraver, greater than he, a better "translator" and even a better "interpreter" has arisen with whom he will find it in vain to compete. The *inertia* of his academic preponderance, hold on to it as he may, will avail him nothing. His great automatic rival, the sun, will outshine him at last; and the plaintive offer of a prize for his recovery — for the restoration of "The Great English School of Line Engraving" — which I gather from the speech of the president at a recent dinner of the Academy, is to be its magniloquent title, will do nothing to revive him. The only fault I have to find with him, therefore, and with the body of which he is a part, is that being moribund, and contributing little or nothing to art, or at best nothing better or so good as we saw on the screen, he should be holding his position to the damage and exclusion of his more original and intelligent rival, and, by means of the opportunities afforded him by the position he holds, be depriving him of his due share of academic representation. His right to this exclusive occupation, and the power of obstruction which it gives him, as well as the right of the Academy to invest him with that power and uphold him in it, I respectfully challenge. Year after year, for now upwards of twenty-five years, original etchings and engravings, many of them destined to live when much of the *ad captandum* and mechanical steel-plate engraving of the day shall have been forgotten, have been sent into the Academy, to be, if not turned out again, thrust into corners, and hung without order or distinction among engraved *réchauffées*, and what may not improperly be called the odds and ends of the exhibition. In no single instance, during the whole of that time, has the slightest notice or encouragement been given to any one of them; while, in opposition to the best traditions of the Academy, which repudiates the copyist in any other shape, the mechanical engraver, the adapter of other men's work to purely commercial purposes, has been accorded its fullest honours, and even put upon the council, whence, if so minded, he may effectually stamp out the efforts, and mar the fortunes of his more legitimate rivals. That the ostracism here complained of has the approval of the more enlightened members of the Academy—several of whom are etchers, and more promising to become so—is not suggested for a moment. Still the fact remains, and it is no explanation of that fact to say, as has been somewhat unhandsomely said, that the complaints justly and necessarily made of it imply an attack on the Royal Academy. Meanwhile, and notwithstanding the discouragement he has met with, it is the humble belief of the writer of this paper, that the efforts which he and others have now been making for so many years have been in the true interests of art, the artist, and the public, and he will even add, of the Royal Academy itself. Of art, since if his views were accepted, it would restore to every branch of it that inestimable quality of originality, which, as has been shown, is its first principle; of the artist, since it suggests to him a ready and legitmate means of extending his reputation, increasing his income, and insuring for his work a more painter-like representation than it gets at present; and of the public, by giving them, instead of art furniture, something to hang on their walls capable of exciting their interest, elevating their taste, and speaking to their intelligence. Nor to the Royal Academy itself, as representing the profession of art, has the service rendered by the much-abused amateur been less obvious, since, by spreading a love of art and some understanding of it among classes hitherto unpenetrated by it (as is being done systematically, and at their own expense, by the Burlington Fine Art Club), for instance, he enlarges the painter's market, and becomes the remote, if not the proximate, cause of that increase in his fortunes which is a phenomenon of the age. To deride and discredit him, therefore, is, to say the least of it, an unintelligent mistake. Nor, considering that, before the great tempter in the shape of the dealer came to him, it was to the amateur—the lover of art for art's sake—that he looked for the sale of his work, is the present attitude of the painter towards him either generous or becoming.

And there is yet another thing that members of the Royal Academy, anxious for its honour, should not forget while considering the question suggested by this paper, and that is that, by persistently refusing, till too late, to recognise the claims of the great school of English water-colour painting, it is indirectly responsible for its decline, and directly responsible for the painful fact that such men as David Cox, Peter de Wint, W. Hunt, and Samuel Palmer, lived and died outside its walls. It is no excuse for this painful instance of neglect and injustice to say that, the charter of the Royal Academy being founded in oil, no room can be found in it for the painter in water-colour. All that can be said to that is, that it ought not to be founded in oil, but on art; and, again, not on one, but on every form of art which may properly be considered "fine art." Suppose, as a *reductio ad absurdum*, it had been founded on water—then the fresco painters would now be at the top, and the oil men nowhere. How would they like that? The time would surely seem to have come when, on the simple ground that the material employed in art production has nothing to do with art, the etchers and the water-colour painters now refused representation in the Royal Academy, may reasonably demand it; and if, by the charter of the Academy as it now stands, such reasonable representation cannot be accorded them, then that a charter so little in accord with the intelligence and wants of the age should be altered, and the injurious monopolies which it sanctions and protects, done away with. Or, as a *pis aller*, why not, as is actually done in the French *salon*, divide the art of engraving into the two classes, which I have here suggested for it; that is to say, into "L'eau forte" and "La Gravure," and give to each a distinct representation. To refuse to do so, as the Academy is doing, is simply to remain behind the age, and to justify to the fullest extent every word here written.

The question, however, remains, not what the Royal Academy may or may not choose to accept as forms of art worthy of its encouragement, but which of the two forms of engraved art—that which is original, or that which is not—has most claim—extra muros academiæ—to be considered "fine art." That question, I venture to think, has been fairly put and fairly answered in the present paper.

APPENDIX I.—ORIGINAL ENGRAVER-ETCHERS.

Note.—There is no pretence in these tables, roughly drawn up, to give anything like a full, or even a correct account of the whole group of original engravers.

Spain.

Great Masters.

	Born.	Died.
Ribera	1589	1656

Lesser Masters.

Goya	1746	1828
Fortuny	—	—

Italy.

Great Masters.

Andrea Mantegna	1431	1506
Marc Antonio	1480	1530

Lesser Masters.

Jacopo di Barbari	1475	1516
Leonardo da Vinci	1452	1519
The Campagnolas	—	—
Niccoletto da Modena	1460	
A. de Brescia (flourished)	1510	
Andrea Zoan	1480	1520
Marco da Ravenna	(?)	1527
Agostino Venetziano	(?)	1536
Bonasone	1510	1580
Eneas Vico	1523	1567
The Ghisis (flourished)	—	
Salvator Rosa	1614	1673

Germany.

Great Masters.

Martin Schongauer	1420	1499
Albert Durer	1471	1528
Hans Holbein	1494	1543

Lesser Masters.

Bürghmair (wood)	1473	1531
Schanflein „	1490	1540
Brosamer „	1506	1560
The Cranachs „	1575	1586
Altdorfer „	1511	(?)
Aldegraver „	1502	—
Israkel Van MecKench	1424	(?)
The Behams (flourished)	1540	

Holland.

Great Masters.

Rembrandt	1607	1669

Lesser Masters.

Lievens	1607	1663
Bol	1611	1681
Van Vliet	1610	—

	Born.		Died.
Ostade	1610	....	1685
Teniers	—	....	—
Bega	1620	....	1664
Dusart	1665	....	1704
Paul Potter	1625	....	1654
Berchem	1624	....	1683
K. du Jardin	1635	....	1678
The Van der Veldes (flourished)	—		
Roos	1631	....	1685
Stoop	1610	....	(?)
Peter de Laer	1613	....	1673
De Bye	1612	....	(?)
Both	1610	....	1650
Swaneweldt	1620	....	1690
Waterloo	1618	....	(?)
Ruisdael	1625	....	1681
Everdingen	1621	....	1675
Bakhuizen	1631	....	1709
Zeeman	1612	....	(?)

FLANDERS.

Great Masters.

Lucas van Leyden	1494	....	1533

Lesser Masters.

H. Soltzius | The Saddlers

FRANCE.

Great Masters.

Claude	1600	....	1682
Nanteuil	1630	....	1678
Meryon	1821	....	1868

Lesser Masters.

Edelinck	1627	....	1707
Masson	1636	....	1700
The Drevets (flourished)	1664-1739		
Poussin	1597	....	1665
Joseph Vernet	1712	....	1786
The St. Aubyns (flourished)	1720-80		
Jacque, Modern	(?)	....	(?)
Jacqmart, Modern	(?)	....	(?)

ENGLAND.

Great Masters.

Van Dyck	1509	....	1641
Hollar	1607	....	1677

Lesser Masters.

Elstracke (flourished)	1620		
De Pass	—	....	—
Vostermans	1580	....	(?)
P. Pontius	1596	....	(?)
The Bolswerts (flourished)	1580-86		
The Vischers (flourished)	1640		
Faithorne	1620	....	1691
Gaywood (flourished)	1660		
Hoobraken	1698	....	(?)
Cecil (flourished)	1630		
Loggan	1630	....	(?)

The etchers again divide themselves into the following Schools. Etchers of Holland, France, and England, constituting the Northern Schools; and etchers of Italy and Spain, constituting the Southern School. Of the Northern School, that of Holland is immeasurably the most important. It divides itself as follows:—

I.—THE NORTHERN SCHOOL.

1. *Portraiture represented by*

	Born.		Died.
Rembrandt	1606	....	1669
Lievens	1607	....	1663
Van Vliet	1610	....	(?)
F. Bol	1611	....	1681

2. *Genre represented by*

Ostade	1610	....	1685
Teniers	1610	....	1694
Bega	1620	....	1664
Dusart	1665	....	1704

3. *Animal Life represented by*

Paul Potter	1625	....	1654
Berchem	1624	....	1683
K. du Jardin	1635	....	1678
Van der Velde	1639	....	1672
Roos	1631	....	1685
Stoop	1610	....	(?)
De Laer	1613	....	1673
De Bye	1612	....	(?)

4. *Landscape represented by*

Rembrandt	1606	....	1669
Both	1610	....	1650
Swanewelt	1620	....	1690
Waterloo	1618	....	(?)
Ruisdael	1625	....	1681
Everdingen	1621	....	1675

5. *Seascape represented by*

Bakhuizen	1631	....	1709
Zeeman	1612	....	(?)

FRANCE.

Claude	1600	....	1682
The St. Aubyns (flourished)	1720-80		
Meryon	1821	....	1868

ENGLAND.

Van Dyck	1509	....	1641
Hollar	1607	....	1677

Turner and the moderns.

II.—THE SOUTHERN SCHOOL.

ITALY.

Parmegiano	1503	....	1540
Meldolla	1522	....	1582
Annibale Caracci	1560	....	1609
Guido	1575	....	1642
Contarini	1549	....	1605
The Siranis	1626	....	1670
Della Bella	1610	....	1664
Castiglione	1616	....	1670

	Born.	Died.
Salvator Rosa	1614	1673
Canaletto	1607	1768

SPAIN.

	Born.	Died.
Ribera	1589	1656
Goya	(?)	(?)
Fortuny	(?)	(?)

There is still another group of the mezzotinters, among which, however, with the exception of Ludwig von Siegen, who invented the process, Prince Rupert, Sir Christopher Wren, Evelyn, and Place, there are few that are original, though many very celebrated artists.

APPENDIX II.—LIST OF BOOKS INDISPENSABLE TO COLLECTOR.

BARTSCH—Le Peintre-Graveur. T.21. 8vo. 1803.

BLANC, CHAS.—L'Œuvre complet de Rembrandt. T.2. 8vo. Paris, 1859-64.

BOSSE, A.—Traicté des Manières de Graver, &c. Paris. 1645.

BRYAN—A Biographical and Critical Dictoinary of Painters and Engravers. 2 vols. 8vo. 1865.

DUPLESSIS, GEO.—Histoire de la Gravure. 4to. 1861.

——— Les Merveilles de la Gravure. 8vo. 1869.

HAMERTON, P. G.—Etching and Etchers. 8vo. 1876.

HEINECKEN, C. H. VON —Idée Générale d'une collection d'Estampes. 8vo. 1771.

MEYER, Dr. JULIUS—Allgemeines Künstler-Lexikon. 1872.

NAGLER, Dr. G. K.—Neues Allgemeines Künstler-Lexikon. 22 Bde. 1835-52.

——— Die Monogrammisten, &c. 8vo. 4 vols. 1858-71.

OTTLEY, W. YOUNG—An Inquiry into the Origin and Early History of Engraving upon Copper and Wood. 2 vols. 4to. 1816.

PARTHEY, GUSTAV—Wenzel Hollar Beschreibendes Verzeichniss seiner Kupferstiche. 8vo. 1853.

——— Nachträge und Verbesserungen zum Verzeichnisse der Hollar'schen Kupferstiche. 8vo. 1858.

PASSAVANT, J. D.—Le Peintre-Graveur. T.6. 8vo. 1860-64.

PIOT, EUGENE—Catalogue raisonné des Estampes gravées à l'eauforte par Claude Gellé.

PRINT COLLECTOR, THE—An Introduction to the knowledge necessary for forming a Collection of Ancient Prints. Small 4to. 1848.

ROBERT-DUMESNIL, A. P. F.—Le Peintre-Graveur Français. T.8. 8vo. 1835-50.

SEYMOUR HADEN, F.—About Etching. F. Keppel, N. York, Vol. I. 1878-9.

——— The Etched work of Rembrandt. Macmillan. Vol. I. 8vo. 1879.

SOTHEBY, S.—Principia Typographica. 3 vols. folio. 1858.

STRUTT, JOSEPH—A Biographical Dictionary of Engravers. 2 vols. 4to. 1785.

THAUSING, MORIZ. — Dürer, Geschichte seiner Kunst, &c. 8vo. 1876.

WEBER, HERMANN — Catalogue des Estampes anciennes. 8vo. 1852.

WILLSHIRE, W. H.—An Introduction to the Study of Ancient Prints. Vol. II. 8vo. 1877.

WILSON, THOS.—A Descriptive Catalogue of the Prints of Rembrandt. 8vo. 1836.

ZANI, ABBATE P.—Materiali per servire, &c. 8vo. 1802.

DISCUSSION.

The CHAIRMAN said the paper had been most interesting and suggestive, and all who loved art in any shape or form must have been delighted to hear the masterly way in which the subject had been treated. Mr. Seymour Haden had not gone into any comparisions of individual work, but had simply dealt with the relative merits of the two methods, viewed as art alone. There was no doubt that if the Royal Academy of Art was, as everyone understood, a society created especially to develop and foster art, it should be catholic, large, and cosmopolitan.

Mr. FORTNUM said he had not devoted any special attention to this branch of art, and was not prepared to add anything to what had been said by Mr. Haden. He thoroughly agreed with his views, as he could see that an etching was really an artist's direct drawing on the copper-plate, instead of on paper. An etching was thus equivalent to a drawing, which an ordinary engraving was not.

Mr. PFOUNDES said there was a kind of etching on copper coming very largely into use in Japan, of which he had specimens at home. He regretted he had not brought some with him, in order to submit them to the judgment of so good a critic as Mr. Seymour Haden.

Mr. SEYMOUR HADEN said he had lately become aware, quite accidentally, of the great antiquity of the etching process. He had purchased, in Nuremberg, a halberd of the 15th century, the blade of which was entirely etched back and front, and, as was the case with all great works of art at that period, without any repetition of the design in any part. Every square inch was entirely covered with original work. There had been an idea that etching was a later branch of art than engraving; but there was every reason to believe that it was anterior, and that the armourers used it even earlier than the artist.

Sir LEWIS PELLY, K.C.B., asked if Hogarth should not be included in the list of painter-engravers.

Mr. HADEN said he must certainly be included, but he had been thinking more of painters somewhat

earlier, when making out the list. At the same time, Hogarth was not an etcher. He engraved his pictures in a formal way, and very much on the same principle as an engraver of the present day would do. There was nos pontaneity about them; in fact, the modern form of engraving had fairly begun before his time and he adopted it. Turner was also an original engraver, or etcher, but his etchings were merely means to an end—to the filling in of an engraving; they were the backbone to engravings made by other hands; to give them force, character, and quality, he etched them with the strong line that was seen in the *Liber Studiorium*. They were not done by Turner with a view to an ultimate end as a work of art, but merely to give character to the work of the mechanical engraver.

The CHAIRMAN regretted there was no one present who felt inclined to take the other side of the question. With reference to events which had recently been happening in another part of the world, he had made the remark that in fighting there were two dangers; one, that of not beating your enemy sufficiently, and the other of beating him out of existence altogether, so that there was no one left to make a treaty with. This was somewhat the case with Chili and Peru, and he was afraid Mr. Haden's paper had had the same sort of effect. It was so conclusive, that there was no possibility of making any fight against it. That being the case, he had only the pleasant duty of proposing a hearty vote of thanks to Mr. Haden for his excellent paper.

The vote of thanks was carried unanimously.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, May 24th; WILLIAM SPOTTISWOODE, LL.D., P.R.S., Vice-President of the Society, in the chair. The paper read was "The Development of Electric Lighting," by J. E. H. GORDON, B.A.

The report will be printed in a future number of the *Journal*.

INDIAN SECTION.

Friday, May 25th; Sir GEORGE BIRDWOOD, M.D., C.S.I., Vice-President of the Society, in the chair. The paper read was "Some Notes on the Domestic Architecture in India," by C. PURDON CLARKE.

The report will be printed in next week's *Journal*.

FOREIGN AND COLONIAL SECTION.

Tuesday, May 29th; W. MCCULLAGH TORRENS, M.P., in the chair. The paper read was "Queensland: its Progress and Resources," by ARTHUR J. STANESBY.

The report will be printed in a future number of the *Journal*.

Miscellaneous.

HYGIENE & LIFE-SAVING EXHIBITION, BERLIN, 1883.

The success of the Hygiene and Sauvetage Exhibition, held at Brussels in 1876, induced the German Hygienic Association to originate a German Exhibition of the same character. At the meetings of this Association and the German Society of Public Medicine, both held in 1881, at Hamburg, the plan of an Exhibition to have been held in Berlin last year was agreed upon. The fire, however, which occurred on the 12th May, 1882, rendered it necessary to put off until the present year the holding of the Exhibition. The primary objects of the demonstration is to convey a thorough idea of the rescuing service of Germany, both in war and peace, between which service and that of public health there is no very definite line of demarcation. At the same time, it was thought too ambitious to give the Exhibition an intermediate character; but, in restricting it to a "General German Exhibition," the committee rely upon securing the co-operation of Austrian and German Switzerland. At the same time, the productions of other countries are not excluded; but these are not grouped by nationalities. The Exhibition is under the protection of the Empress Augusta, and the President of the Central Committee is Herr Hobrecht, Minister of State.

The classification of the exhibits differ from that generally adopted, as they are grouped, not according to their origin, but their practical application, so that the visitor can better become acquainted with their value in connection with the use for which they are intended. Section A, comprising groups from 1 to 25 inclusive, is devoted to hygiene; while Section B, groups 26 to 40 inclusive, relates to life-saving. These are again subdivided into—1, material objects; and, 2, publications and drawings. Drawings and plans of buildings must be accompanied by estimates of their cost, and also by information as to the localities where they are to be erected.

SECTION A.—1ST DIVISION.

Group 1.—*Soil and Atmosphere*.—Means for recording the level of water in rivers, and for disinfecting the soil and air; instruments for measuring the

pressure of the atmosphere, the humidity of the air, and the composition of foul air.

Group 2.—*Streets, Roads, and Squares.*—Methods for consolidating roads, &c.

Group 3.—*Removal of Waste and Fœcal Matters.*—Appliances for cleansing streets, water courses, and sewers; arrangements for getting rid of waste substances; utilisation of waste; knacker's yards; means for preventing the escape of lighting gas.

Group 4.—*Water Supply.*—Samples and analysis of water, and appliances for its examination; pumps, valves, pipes, filters, hydrometers, and drinking fountains.

Group 5.—*Public Illumination.*—Gas-works, gasometers, and electric light apparatus; means for preventing the subterranean infiltration of gas; and reservoirs for the conveyance of lighting gas.

Group 6.—*Food Supply of Large Towns.*—Markets, slaughter-houses, mills, bake-houses, *trinkhalls*; arrangements for the transport of food substances by road, railway, and water; food preservation; analysis of provisions; and utilisation of slaughter-house refuse.

Group 7.—*Public Washhouses and Laundries.*—Their machines and appliances.

Group 8.—*Public Baths.*—Hydropathy and appliances for teaching the art of natation.

Group 9.—*Public Instruction.*—Kinder-gärten, schools, colleges, gymnasia; schools for the deaf, dumb, and blind.

Group 10.—*Dwelling-houses.*—Protection against damp; appliances for heating, lighting, ventilation, and water supply; telegraphs and speaking tubes.

Group 11.—*Buildings for the Permanent Dwelling of a large number of persons.*—Orphan and foundling hospitals; normal and boarding schools; barracks, workmen's dwellings, and prisons.

Group 12.—*Buildings for temporary assembling of a large number of persons.*—Places of worship, administrative establishments; theatres and concert rooms; soup kitchens and night refuges.

Group 13.—*Hotels, Restaurants, and Coffee-houses,*—Their heating, lighting, ventilation, and water supply.

Group 14.—*Factories and Laboratories.*—Protection from accident, and the special dangers inherent to various trades; means for counteracting the pollution of water courses, and for preventing the generation of injurious gases; smoke consumption.

Group 15.—*Rural Economy.*—Labourers' cottages, cattle sheds, and dairies.

Group 16.—*Alimentation.*—Infants' food and preserved foods; provisions for the army and navy; appliances for testing and preserving food.

Group 17.—*Locomotion on Land.*—Railways, tramways, and electrical railways; refreshment and sleeping cars; transport of explosives and noxious substances.

Group 18.—*Travelling by Water.*—Steamers for sea and river; troopships; passenger and emigrant vessels; fresh-water supply and medical assistance.

Group 19.—*Clothing and the Hygiene of the Skin.*—Articles of clothing, with reference to the health; and special equipments.

Group 20.—*Contagious Diseases.*—Transport and isolation of patients; instruments for vaccination; and appliances for the conservation of lymph.

Group 21.—*Health Establishments.*—Civil and military convalescent and other hospitals; means for destroying the germs of disease; transport of sick and wounded; medical and surgical instruments; and the fitting up of dispensaries.

Group 22.—*Disposal of the Dead.*—Mortuaries and anatomical lecture-rooms; vehicles for the transport of corpses; inhumation and cremation; the disinfection of cemeteries and battlefields.

Group 23.—*The Veterinary Art.*—Appliances for traction and preventing animals from becoming dangerous; means for their avoiding contagious diseases; veterinary appliances for the use of farmers; disinfection and destruction of the bodies of diseased animals.

Groups 24 to 25 relate to the publications and drawings in connection with the above.

Section B.—Life-Saving.

Group 26.—*Life-saving at Fires.*—Means for rendering materials incombustible, and for preventing the spontaneous combustion of coal; fire-proof rooms and safes; fire-indicators; chemical substances for extinguishing fires; firemen's equipment.

Group 27.—Lightning conductors.

Group 28.—*Floods.*—Appliances and organisations for indicating a rise in the water of rivers.

Group 29.—*Explosions.*—The storing and transport of explosive gases and inflammable substances; gas-escape indicators.

Group 30.—*Protection against Accidents in Travelling by Land.*—Runaway horses and brakes; railway signals, level crossings, and automatic couplings; colour blindness; assistance in cases of accident or break-down.

Group 31.—*Protection against Accidents on the Sea and Lakes.*—Lighthouses; sea and fog signals; rescue of the drowning—swimming belts and life buoys.

Group 32.—*Protection for Divers.*—Divers' dresses, air-tubes, and lamps.

Group 33.—*Protection for Miners.*—Appliances for preventing accidents from rope traction and the diseases which affect miners; fire-damp indicators and safety lamps.

Group 34.—*Machinery and Steam-boilers.*—Alarm signals for preventing boiler explosions; automatic feed appliances, and pressure gauges.

Group 35.—*Relief of Victims to Accidents.*—Means for preventing death by suffocation, drowning, and poison; organisation of rescue gangs.

Group 36.—*Succour to the Sick and Wounded in Battle.*—Equipment of volunteer ambulance corps; improvised litters and railways; transport of the wounded in mountain districts and on board ship.

Group 37.—*Ambulance Service during War.*—Models and organisation of tents, ambulances, and lazarettos.

Group 38.—*Surgical Treatment of the Wounded.*—Splints and bandages; surgical instruments; special hygiene.

ECONOMIC PLANTS IN JAMAICA.

The Director of Public Gardens and Plantations in Jamaica has just issued his annual report for the year ending 30th September last. Mr. Morris draws especial attention to the drought which prevailed in the island in the early part of the year, "caused," he says, chiefly by the failure of the May rains (or "seasons") coming after a succession of dry months with parching winds, "which thus had a prejudicial effect on all agricultural operations. The effects of this drought was severely felt among the young coffee and cinchona plants in the Blue Mountains district. It is a subject of common remark amongst old planters that the 'seasons,' or periodical rains, which have hitherto fallen with great regularity and copiousness during the months of May and October of each year, are becoming more and more uncertain and irregular, and the effect of these conditions are clearly shown in the precariousness of the agricultural products effected by them. These remarks apply chiefly to the southern slopes of the Blue Mountains, and to such other districts stretching south and west where coffee and provisions are being chiefly raised."

Mr. Morris, in drawing especial attention to this matter, says the whole subject of the maintenance of existing forests on ridges and mountain tops, as well as in the neighbourhood of springs, and along the banks of rivers and streams, is one which he commends very earnestly to the attention of proprietors of land in the island; and it is to be hoped that the subject will also receive the careful consideration of the Government, so that steps may be taken to prevent, as far as possible, an aggravation of the present evils.

Notwithstanding many unfavourable climatic changes during the past three years, many of the larger staple articles of cultivation in Jamaica have shown a marked improvement. The sugar crop has been unusually large, and the coffee crop above the average; low prices, however, ruled for this article, and others. Many of the growers of lowland coffee suffered severely. "Among minor products, the cultivation of bananas has become a large and promising industry; the exported value of this fruit during the past year reached £88,737, as compared with £22,665 for 1880; the export of oranges also shows a considerably increased value, that for the past year being £33,684, as compared with £20,082 for the year 1880."

During the prevalence of the drought large patches of pastures, both in Portland and at King's House, were seriously damaged by the attacks of the mole cricket (*Grillus campestris*), which, gnawing the roots of the grasses, caused them to die over extensive areas. Mr. Morris expresses his belief that this pest is much more common in the island than is supposed. After the grass is once killed, it seldom grows over the same area again, worthless weeds taking its place. "Many suggestions have been made to deal with the evil, but deep digging and treating with caustic lime, while the insect is in the larval state, appears to be the only effective means of destroying it. Careful rolling of the surface with a heavy roller when the ground is soft might also be tried, as well as assiduously destroying the adult insects whenever practicable." In connection with this subject, Mr. Morris further says:—"While on the subject of insect pests in this island, I would desire to draw attention to the fact that I have noticed such pests are most prevalent in the neighbourhood of villages, and in localities where bird life is rare or entirely absent. Owing to the indiscriminate slaughter of small birds in this island, where every one with means sufficient to purchase a gun can shoot all the year round, bird life (especially humming birds, redstarts, and others of an insectivorous character, and with bright plumage) is becoming more and more rare. It would be very desirable to restrict, if not entirely abolish, the shooting of all birds in this island during certain seasons; but I would earnestly recommend that, at least, protection be given to the large class of insectivorous birds, which is now practically being exterminated."

Under the head of "Cinchona Plantation," it is pointed out that the experience of late years has fully proved the suitability of Jamaica as a cinchona-growing country, and that it may well develop into a remunerative enterprise in the hands of planters. Jamaica grown cinchona barks have competed side by side with those from other countries in the markets, and have commanded a ready sale. Three years since only three kinds of cinchona, namely *Cinchona succirubra*, *C. officinalis*, and the so-called *C. calisaya*, now proved to be identical with C. hybrid or *robusta* of Ceylon and India, were in cultivation in Jamaica. Since then, however, numerous kinds have been introduced, amongst them the various forms of crown barks, red barks, yellow barks, grey barks, ledgeriana, &c. Especial attention has been given, during the past year, to the successful introduction of *Cinchona ledgeriana*. (See also p. 729.) In addition to the plants already established on the Government plantations, several thousands have been distributed amongst private planters, and each lot of these will, doubtless, form a nucleus from whence seeds and cuttings may hereafter be obtained, and thus prove most valuable acquisitions to private plantations. Regarding the results of bark sales for 1881-82, it seems that the net amount realised was £2,419 5s. 7d. The highest

price per pound was obtained for fine root bark of *C. officinalis*, and this reached 8s. per pound.

Though cinchona occupies by far the largest share of attention in the present report, other useful plants are not lost sight of, as, for instance, sugar canes, Liberian coffee, timber, and fruit trees, banilla, nutmeg, cinnamon, &c., are all duly considered.

GOVERNMENT PATENT BILL.

On Tuesday afternoon, May 29, Mr. Chamberlain received at the Board of Trade a Scotch deputation, representing the Glasgow Philosophical Society and the Inventors' Institute of that city, and similar institutions in Edinburgh and other Scotch towns. The deputation was introduced by Mr. Anderson, M.P., and amongst those present were Dr. Cameron, M.P., and Mr. A. H. Brown, M.P. Sir William Thomson, F.R.S., speaking on behalf of the Glasgow societies, called attention to several amendments they would like to see introduced into the Patents for Inventions Bill. They would like first of all to see the appointment of Government Commissioners, such as existed in America, who would have the power to see that new patents did not interfere injuriously with old ones. Then as to the question of fees, they thought that these should only cover expenses; and it did not seem fair to call upon a successful inventor to pay £150, to cover the expense that would be incurred by the immense number of would-be inventors who would rush to the office if the initial fee was made as low as £1. They also desired an extension of the term of a patent from fourteen to seventeen years. Mr. Gowans, of Edinburgh, also spoke on behalf of the deputation. In reply, Mr. Chamberlain stated that when the Patents for Inventions Bill came before the Grand Committee on Trade, matters of details would be thoroughly sifted, and the Government would be prepared to accept such amendments as commended themselves to the majority of the Committee. They must, however, keep separate what they considered matters of detail and questions of principle. Among the questions of principle, he at once said, was the examination for novelty, such as had been frequently suggested. He was not at all satisfied that the system which obtained in Germany and America was a satisfactory system. In America, not only were an immense number of inventions allowed to pass which were not properly subjects for patents, but good inventions were prevented from being patented by reason of this preliminary examination. The Commissioners had to delegate their functions to more than 100 Assistant Commissioners, who were generally badly paid, were not always independent, and were subject to very considerable pecuniary temptations. The decisions of these Assistant Commissioners were very frequently appealed against, and the result was, that a patent was a dearer thing than in England. As to the question of fees, he could not admit that they were bound to asert as a principle that the fees should in no case cover more than the expenses of the office. It was provided in the Bill that hereafter the fees might be diminished at the instance of the Board of Trade by means of a mere Parliamentary resolution. As to the method of the payment of the fees—whether they should be paid in three several payments or annually—any annual payment to which he could assent would make the real payment larger than he intended it to be. For instance, in order to obtain the £150 required, £11 annually for fourteen years would have to be paid. The poorer class of inventors, who, under the Bill, would get a a four years' patent for £4, would not be able to pay £11, or perhaps even £5 per annum. Dealing with the proposed duration of a patent, he said the feeling of the House of Commons was adverse to extending it. Lastly, there was the question of the Government claim to inventions, which was merely a re-stating and renewal of the claim already established by the great departments of the State, especially the Army and Navy, and that was based upon considerations of public security and public interest. He suggested to the deputation that they should lay their views on this subject before the Admiralty and the War-office.

TESTS FOR COTTON YARNS.

The *Central Blatt für Textil Industrie* has recently published a detailed account of a series of instruments made by a Swiss firm for testing the strength and regularity of cotton yarn. It is remarked that the determination of the properties referred to is of importance to textile manufacturers, and yet there seems hitherto to have been a want of systematic experiments; most consumers trying the tension of a few threads when purchasing, or trusting to the known suitability to their requirements of certain established marks, and paying even higher than market value for such yarns. Those buyers who have been attempting regular tests would seem to have been wanting in system in doing so, and it is therefore considered that Messrs. Hottinger and Co.'s instruments will be generally appreciated. They are classified as follows:—

1. Strength-testing measure for fine cotton yarn, from No. 40 to No. 200, serving also for testing silk and woollen yarns.

2. The same instrument in the form of a watch, 2 inches in diameter, and divided into degrees of strength by 10 grammes (one third of an ounce), up to 800 grammes (28½ ounces).

3. Strength-testing machine for coarser cotton yarn, which can be used up to No. 50.

4. Strength-testing machine for twisted yarns, sewing threads, sewing silk, and linen yarns.

5. Dynamometer for testing stuffs, string, paper, &c., with burdens up to 66 lbs.

6. Dynamometer for testing tissues, leather, saddlery, goods, wire, &c., for strength and extension up to 220 lbs.

The instruments for stretching cotton yarn until it breaks are three in number.

The firm in question has drawn up, a table showing the basis on which the strength of yarn can be calculated, which may be summarised as follows:—

Weak.—Varying from 31½ ounces in No. 4 to 3½ ounces in No. 40.

Medium.—Varying from 35¾ ounces in No. 4 to 1⅞ ounces in No. 120.

Strong.—Varying from 44½ ounces in No. 4 to 2 ounces in No. 120.

Very Strong.—Varying from 48 ounces in No. 6 to 2½ ounces in No. 120.

It is remarked that one trial is never sufficient to determine the strength of yarn, but a certain number of tests are required. Ten may sometimes be enough, but the result is always more certain in proportion to the number of trials made.

Regularity is, however, as important as strength. The definition of this property is arrived at by adding up the various weights obtained by the previously described experiments, and finding the average. The weights below this average are then taken, and the difference between their average and that of the whole represents the variation in strength. Thus, if ten trials produce an average weight of 6 ounces, and the average of the weights *under* the mean weight is 5½ ounces, the difference between the two averages is about 9 per cent. When this difference is under 10 per cent., yarn may be classed, according to the proposed standard, as "very regular;" and when the margin is under 15 per cent., as "regular;" when this limit is exceeded, it is called "irregular."

The appliances in question are now on view at the Zurich Exhibition, in group 32.

VINE DISEASE IN FRANCE.

Her Majesty's Vice-Consul at La Rochelle says that to the various diseases to which the vine is subject, must be added the *Ponospora viticola*, or mildew, which has been undoubtedly introduced by vines from America. For a long time, the vineyards in certain parts of the United States have been ravaged by this disease, but it appears to have been totally unknown in France prior to 1878. From an account given by a chemist who has been engaged in making researches on the subject, it appears that the mildew is a species of fungus which attacks the under side of the leaves, turning them brown and dry until they eventually fall off, and spreads according to the dampness of the atmosphere. The stems, deprived of their foliage, can no longer nourish the grapes, which shrink up before ripening. The spore of these species of fungus germinate in one night in a drop of water, consequently, when the air is dry, and there is no rain or dew on the leaves, the malady makes no progress, while proximity to the sea, and a misty humid condition of the air, favour its development. Later in the season, it forms another spore in the tissue of the leaf, which propagates the disease for the following year; it is, therefore, important to collect and burn all dead leaves after the vegetation of the vine has ceased. It is easily distinguishable from the *oïdium*, as it produces a distinct and clearly defined spot like a burn on the leaf; the fungus is thicker, and of a whiter colour, and has no smell; the mildew also does not form a boss on the upper side of the leaf corresponding to the spot attached underneath, as is the case with the *erinium*. The mildew has already caused considerable damage in the south-west of France and Algeria, and it appears to be rapidly spreading.

THE PRODUCTION OF SALT IN TURK'S ISLAND.

Turk's Island, says Consul Sawyer in his last report, is particularly well adapted by nature for the manufacture of salt. The island is about five miles long and two broad, the south-east side being fringed with a high bank, and having the appearance of having been formed by the action of the waves. This wall affords protection from a sudden inundation by a tidal wave. Running through the island is a *sag*, or valley, in which are located the salinas and salt ponds. The land on which the ponds are found is on the level with the sea. A canal conducts the water from the sea to the reservoir, which feeds the pans when required, or when the elements have converted the sea water into brine strong enough to be used in the pans. There are two kinds of saline reservoirs for the conversion of salt water into salt, one is the saline proper, and the other a salt pond, the latter having a never-failing supply of water, being fed by springs of salt water. The saline proper is a flat, and is supplied with water from the ocean by the canal, which can be opened and closed at will. The first water let in from the ocean flows into a large reservoir, holding about half as much as the entire area of the salina. The water remains in this receptacle some weeks, evaporation continually going on by the action of the wind and the sun. When it reaches 60° or more, as measured with a salometer—salt water being between 10° and 12°—it is turned into the pans, this operation being effected either by hand mills or wind mills. At 60° all foreign matter held in solution is precipitated. The pans vary in size, but are generally from one-eighth to three-fourths of an acre in area, and are laid out so as to allow water-courses between each, for the purpose of obtaining a supply of brine from the main reservoir. The divisions are separated by walls made with stone and mud. These are about two feet high, with a width from three to four feet. These pans are generally raked out, and

the *débris* removed once every year. The brine seldom crystallises into pure salt, unless there has been a month's absence of rain. It becomes a saturated solution at 96°, and commences to crystallise at 110°, as measured by the salometer. To be gathered, the salt is broken up by the hand. It is then raked into rows to be carted into piles or heaps, some of which contains as much as 10,000 bushels. The pans yield from 5,000 to 8,000 bushels per acre during the season. At low water the canal is sometimes opened, to prevent an overflow of the pans from the reservoir after a heavy rain. The crop gathered each year, averages about 2,000,000 bushels. About two-thirds of this quantity is shipped to the United States, and the remainder to various ports in Nova Scotia, as fine salt, or fish salt to supply the fishermen. Of late years, the salt merchants in Turk's Island have erected mills for grinding the salt made, to a fineness suitable for curing fish.

THE PARAGUAY TEA TREE.

The superintendent of gardens and grounds attached to the United States Department of Agriculture mentions in his last report that the department has recently had numerous inquiries regarding the feasibility of growing in the United States a plant similar to the *Ilex paraguayensis*, or Paraguay tea tree, from which the leaves are stripped and used in infusion as an article of food under the name of *maté*, and gives the following description of the cultivation of the tree, and the method employed in the preparation of this article. In rich soils the tree will attain a height of from seventy to ninety feet; it is said to be confined to mountain slopes, never appearing on table lands nor the broad plains which skirt the river beds, while it is plentiful in all the moist valleys that branch out of the extensive chain of mountains that divide the waters of the Parana and Paraguay rivers. For the preparation of *maté* proper, the leaves are dried, or roasted in cast-iron pans, set in brickwork and heated by fires underneath; when the leaves are sufficiently heated, they are pounded in stamping mills worked by water or steam power until reduced to powder, and then packed in bags by means of presses. There are three qualities or sorts of yerba known in the South American markets. The best is said to be prepared from the young leaves when they are about half expanded from the bud, called *caa-cuys;* the second consists of the full-grown leaves, carefully picked and separated from twigs, and frequently the midrib and veins of the leaves are removed; this is called *caa-mira;* the third is the *caa-gnaza* or *Yerva de Palos*, made from older leaves, carelessly broken up with the small branches and leaf-stalks, all of which undergo the roasting and pounding process together. The leaves are also collected and dried in a similar manner to that adopted in the preparation of Chinese tea. This is called *maté* in leaf, and is prepared for use by infusion, and taken with milk and sugar in the same way as ordinary tea. *Maté* in powder is also prepared by infusion, by putting into a small vessel about an ounce of the powder, and pouring boiling water over it; as the fine dust does not fall to the bottom, but remains suspended in the water, the *maté* is taken by means of a sucker, that is, a tube terminating in a small hollow ball pierced with very fine holes. *Maté* contains theine, the same active principle as tea and coffee, but is not possessed of their volatile and empyreumatic oils; it contains less essential oil, more resin than coffee, but less than is found in tea. Chemical analyses show that it contains nearly double the quantity of theine that the same weight of grains of coffee contains, and about the same quantity as tea leaves. The Brazilians recommend *maté* as a nourishing, warm, aromatic, stimulating, and very cheap beverage, its extreme cheapness being a guarantee of its genuineness, as it is not worth adulterating.

NEW SOURCES OF PETROLEUM.

Although petroleum has long been known to exist in Bavaria, it is only quite recently that regular borings have been undertaken, which have proved that its quality is superior to that of Oelheim. Whereas, at Oelheim, a light oil, like that of America, is only found at a great depth, in Bavaria a light oil, of 0·811 specific gravity, which ignites easily and leaves but little residue, is found comparatively on the surface. This product is of a greenish-brown colour, and is rich in volatile matters; at 180° C. (366° Fahr.) it gives out about 14 per cent. of a clear and very inflammable naphtha, of 0·731 specific gravity; and at 320° C. (608° Fahr.) it yields 39 per cent. of a raw yellow oil, of 0·786 specific gravity, which is not so inflammable, and may be used for illumination. At a still higher temperature, there are obtained, successively, 16 per cent. of a reddish-yellow lubricating oil, of 0·834 specific gravity; and then 25 per cent. of an oil containing a large proportion of paraffin, from which lubricating oil and solid paraffin may be extracted. This richness in naphtha and paraffin gives the Bavarian petroleum a value at least equal to that of Pennsylvania, while its distillation is effected with great facility.

A petroliferous stratum has also been discovered in the Limogne valley, near Puy-de-Dôme, in France, and borings undertaken by a new company give strong hopes for the future. At the same time, an oil-spring has also been discovered at Pechelbronn, in Alsatia, at a depth of 138 metres (45 feet), and which at present yields 10·8 tons per twenty-four hours. In Austria public attention is becoming more and more turned to the native sources of petroleum, while in the neighbouring state of Roumania, new companies are being formed to work the oil-springs.

For the extinction of fires due to petroleum M. Schlumburger recommends that bottles of liquid

ammonia be placed on the vessels containing the oil. In the event of a fire, the bottles would break, and the ammoniacal vapours evolved would speedily extinguish it, and prevent an explosion.

CINCHONA LEDGERIANA.

A good deal of interest has always attached to the above species of *Cinchona*, both scientifically and commercially; first, on account of the different opinions held by botanists as to whether the plant is sufficiently distinct from *C. calisaya* for it to be ranked as a species under the well-known name of *C. ledgeriana*, or whether it should more properly be called a variety of *C. calisaya*; and, secondly, on account of the great value of the bark for practical purposes, yielding as it does from 7 to 12 per cent. of quinine. (See *ante*, p. 725.)

At a recent meeting of the Linnean Society, Mr. J. E. Howard, the quinologist, took up this bark as the subject of a paper. After criticising the various points that have been raised regarding the nomenclature of the plant, Mr. Howard exhibited some living plants, the leaves of which were easily distinguished from veritable varieties of *Calisaya* placed side by side with them. The leaves of the former have a fine, lustrous, satiny gloss, and the margins of the leaves are hairy. Some young plants raised from seed obtained from Bolivia, by Mr. T. Christy, F.L.S., were exhibited by him, and several of them were acknowledged to be identical with Mr. Howard's *C. ledgeriana*, while the others undoubtedly belonged to the *Calisaya* "verde" of Weddell and Markham. Mr. Howard gave testimony of the value of these seeds being brought into English commerce, from whence they will find their way into planters' hands in cinchona-growing countries. The supply of this seed has hitherto been very limited, in consequence of the difficulty of obtaining it, not only by collectors, but by long residents in the country, and even by bark cutters themselves.

ZURICH EXHIBITION.

The Swiss National Exhibition was opened at Zurich on the 1st May. This is the first occasion on which the industries of Switzerland have been properly represented, as the two previous Exhibitions—the last of which was held in 1857—were of slight importance. Since that date, the trade of the little republic has made great progress, although there is absolutely no protection of invention. The watch manufacture is chiefly carried on in the cantons of Geneva, Vaud, Neufchâtel, and the Bernese Jura. The other industries are almost entirely confined to the eastern part of the country, of which Zurich is the centre; these are silk and cotton fabrics, and printed stuffs, and embroidery, all of which are largely exported. The silk trade has made great progress of late years, occupying no less than 42,000 hands in Zurich alone, while at Bâle the ribbon manufacture finds work for 12,000. The cotton and woollen manufactures are not very flourishing at the present moment; and many manufacturers have migrated to Italy. Printed stuffs, which are made chiefly at Saint-Gall, Appenzell, and Glaris, employ a large number of hands, a new market having lately been found in the East. The greatest increase, however, has taken place in embroidery. In 1872, there were only 6,300 embroidery machines in three cantons, while there are now 14,800 in thirteen cantons. Goldsmiths' work has declined since 1872, on account of the sharp competition of France, the United States, and Pforzhain in Baden, which has taken away the best workmen. More than half the exhibits consist of engines and machines, the two factories of Escherwyss, at Zurich, and Sulzer, at Winterthum, employing together no less than 2,800 men.

General Notes.

PRESERVATION OF MEAT.—A new process for meat preserving has been discovered by Sigor Pavesi, who is said to have succeeded in keeping pieces of meat for years without their flavour being impaired. During the whole time that it is required to preserve the meat, it is to be kept in a pickle, consisting of water slightly accidulated with nitro-muriatic acid; and when required for use, the meat is dried at a temperature of about 60° Fahr. To avoid a slightly brown colour, the meat may be steeped in plain water before being dried.

ARCHITECTURAL EXHIBITION, BRUSSELS.—The Central Society of Architecture, Belgium, is organising an Architectural Exhibition, with the support of the Government and the Municipal College of the capital. It is arranged to be open from 2nd to 30th September next, in the new Palais de Justice, Brussels. The society appeals to archeologists to lend for the retrospective section drawings of buildings erected previously to 1833, and designed either by Belgian or by foreign architects. Further particulars may be obtained from the secretary, M. Charles Neute, architect, 128, Rue Royale, Sainte-Marie, Brussels.

THE POPULATION OF FRANCE.—According to the last census, France has 37,405,290 inhabitants, women being in a majority of 92,254; and there are 1,601,110 foreigners. Out of the 18,656,518 men, 10,110,601 are single, 7,520,186 married, and 1,025,731 are widowers; while of the 18,748,772 women, 9,280,862 are single, 6,503,353 married, and 1,964,557 widows. As regards occupation, the population is thus distributed:—Agriculture employs 18,204,799 persons, industry 9,324,107, commerce

3,843,447, transports and marine 800,741, the army 552,851, the liberal professions 1,629,768, proprietors and those in receipt of a pension 2,148,173. There are 727,588 persons of no occupation; and those whose occupation is unknown number 173,816.

UNIFORM MERIDIAN AND TIME.—At an early meeting this year of the Paris Academy of Science, the French Minister of Public Instruction asked the opinion of that body as to the reply to be made to the proposal of the American Government for an international conference, with a view to the adoption of a uniform meridian and a universal time. The Commission appointed to consider the matter has expressed an opinion favourable to the conference, and has requested the Minister to appoint the members to represent France at the Washington Conference.

MEMORIAL TO THE LATE REV. ARTHUR RIGG.—Shortly after the death of the late Rev. Arthur Rigg, a wish was expressed by numerous old pupils who received their early education at the Engineering School at Chester, that a permanent memorial of their old master should be provided. A committee was formed, Mr. Percy G. B. Westmacott being chairman, and Mr. Samuel Worssam, hon. secretary. It was decided to erect a marble medallion in the College Chapel. The medallion has just been completed by Mr. J. S. Westmacott, the sculptor, and it is considered by those best able to judge to be an excellent likeness. Surrounding the circular medallion there is a large rectangular framing of Italian marble, with a bold moulding. Below the medallion is a brass plate, bearing the following inscription:—"This medallion is placed here in memory of the late Rev. Arthur Rigg, M.A., for thirty years principal of this college from its commencement in 1839, by some of his old pupils of the science school attached to the college, as a tribute to the founder of the first English school for technical education and practical engineering.—Percy G. B. Westmacott, M.I.C.E., P.I.M.E., chairman of committee; Samuel Worssam, A.M.I.C.E., M.I.M.E., hon. secretary. April, 1883."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 4th...Society of Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. G. W. Wigner, "The Packing of Goods of Delicate Odour, such as Tea, &c." 2. Mr. G. Ward, "The Salt Deposits of the Cleveland District," and other communications."

TUESDAY, JUNE 5th...Royal Institution, Albemarle-street, W., 3 p.m. Professor McKendrick, "Physiological Discovery." (Lecture X.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Biblical Archæology, 9, Conduit-street, Hanover-square, W., 8 p.m. Rev. A. Lowy, "Underground Structures in Biblical Lands."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Prof. Owen, "Embryological Testimony to General Homology." 2. Rev. O. P. Cambridge, "Some New Genera and Species of Spiders." 3. Mr. A. G. Butler, "List of Lepidoptera collected by Mr. H. O. Forbes in the Islands of Timor Laut."

WEDNESDAY, JUNE 6th...Geological, Burlington-house, W., 8 p.m.

Society for the Protection of Ancient Buildings (at the HOUSE OF THE SOCIETY OF ARTS), 3.30 p.m. Annual Meeting.

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. G. Blashill, "Dore Abbey." 2. Mr. C. Romilly Allen, "Ancient Stone Circle, near Liverpool." 3. Mr. W. Wilding, "The Chained Library at Chirbury."

Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

THURSDAY, JUNE 7...National Society for Preserving the Memorials of the Dead (at the HOUSE OF THE SOCIETY OF ARTS), 4 p.m.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 3 p.m. 1. Mr. H. N. Ridley, "New or Rare Monocotyledonous Plants from Madagascar." 2. Mr. George Lewis, "Some Japan Brenthidæ." 3. Mr. T. H. Corry, "Fertilisation of the Asclepiads." 4. Mr. Robert Romanis, "Habits of the Termites of Rangoon."

Chemical, Burlington-house, W., 8 p.m. 1. Ballot for the Election of Fellows. 2. Dr. J. H. Gladstone, and Mr. Alfred Tribe, Laboratory Notes—The Action of Light and Heat on Cane and "Inert" Sugars. Hydroxylamine. Recovery of Iodine from Organic Iodide Residues. A Residual Phenomenon of the Electrolysis of Oil of Vitriol. An Alleged Test for Alcohol. Reaction of the Copper Zinc Couple on Nitric Oxide. The Reducing Action of Spongy Lead. 3. Prof. H. McLeod, "Evaporation in Vacuo." 4. Mr. Spencer N. Pickering, "A Basic Ammonio-copper Sulplate."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. G. Bertin, "The Influence of Religions on Fine Arts in Antiquity."

South London Photographic (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. S. Poole, "Recent Discoveries in Cyprus and Asia Minor."

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

FRIDAY, JUNE 8...Archæological Institution, 16, New Burlington-street, W., 4½ p.m.

Royal United Service Institute, Whitehall-yard, S.W., 3 p.m. Col. Sir Charles B. P. Nugent, "Harbours of Refuge in Connection with the Subject of Convict Labour."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Professor Dewar, "The Electric Arc and Chemical Synthesis."

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

SATURDAY, JUNE 9...Physical, Science Schools, South Kensington, S.W., 3 p.m. Dr. E. Oback, "Improved Construction of the Moveable Ring Galvanometer adopted for Measuring both Strength of Current, and Difference of Potential."

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W. 3 p.m. Prof Turner, "Russian Social Life." (Lecture IV.)

Journal of the Society of Arts.

No. 1,594. Vol. XXXII.

FRIDAY, JUNE 8, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's Annual Conversazione will be held this year in the Buildings of the International Fisheries Exhibition. His Royal Highness the Prince of Wales, President of the Society, has intimated his intention to be present.

The precise date will be announced, when it is fixed by H.R.H. the President, and cards of invitation will then be issued to the members of the Society. Each member will, as usual, receive a card for himself and a lady.

Proceedings of the Society.

INDIAN SECTION.

Friday, May 25th; Sir George Birdwood, M.D., C.S.I., Vice-President of the Society, in the chair.

The paper read was—

SOME NOTES UPON THE DOMESTIC ARCHITECTURE OF INDIA.

By C. Purdon Clarke, C.I.E.,
Architect.

As my paper refers only to domestic architecture, represented by existing buildings, in India, I shall not stop to discuss whether, at an early period, there existed in the country a wide-spread, indigenous and national style. Students of the ancient literature of the Hindus are familiar with florid descriptions of temples, palaces, forts, and private dwellings. But bards and poets are seldom reliable in matters of detail, and as there is little left to testify to their veracity, we are free to accept their statements, or to regard them as we do the oriental scenery of "Lalla Rookh," and regret that they are not true. On the other hand, there is evidence of an attempt, at an early date, to crystallise an existing style, either indigenous or foreign; and at whatever period the portion of their sacred writings, called the "Silpa Shastras," were composed, the Hindus then possessed and practised ecclesiastical, military, and civil architecture.

Fifty years ago, attention was directed to the "Silpa Shastras," and Ram Raz, a most able native scholar, undertook their investigation; but death coming before the completion of his work, this mine of technical information has remained unexplored. His treatise, published in 1834 by the Royal Asiatic Society, makes the date of these books contemporaneous with the decline of Buddhism, and accounts for their being so little known in the following observation:—

"This class (*i.e.*, architects), perhaps jealous of the Brahmans, whose sacerdotal authority they have always opposed with a spirit of independence—or, more naturally, apprehensive of competition in their trade—took particular care to conceal the sacred volumes which have descended to them from the rest of the people; but as they have, on their own part, long been denied the benefit of Sanskrit literature, these treatises could be but of little use to themselves, and the consequences have been that, while the practical part of the science continued to be followed up by them as a kind of inheritance from generation to generation, the theory became gradually lost to the nation."

As Ram Raz shows that minute directions for building a house are given in the "Silpa Shastras," from the choice of the site to the final embellishments with bright colours, and even to the house-warming, naturally it will be assumed that, wherever Hindus build, one style must be found. They do their best to follow the directions of the Shastras there is little doubt; but in practice, local influences and traditions, the requirements of climate, the plenty or scarcity of certain building materials, all play their part in producing local peculiarities, which, in some cases, have developed into apparently distinct styles. These, and the modifications of the

ingrafted arts of alien conquerors, were scientifically examined, grouped, and described by Mr. James Fergusson, who, in preparing his "Handbook of Architecture," published in 1855, succeeded in reducing this chaos to rule and order.

To the notice of the traveller, India presents a most heterogeneous population; and almost every style in the history of art may be found there Indianised, either in existing buildings or ancient ruins. Assyrian, Burmese, and Chinese influences can be traced in the Hindu ornamentation of Southern India. Saracenic, in the Moghul art of Sindh, the Panjab, and Bengal. Moorish forms in the Deccan. A debased Greek treatment, strangely Byzantine in expression, marks the ancient ruins of the Afghan frontier and some temples in Cashmir. Gothic and Renaissance forms are also represented in places where the Portuguese ruled; and, lastly, an English pseudo-classical style, bald and hideous beyond description, introduced by our own people in the last century, still remains, so far as police-stations and kindred constructions are concerned, the official style of the Indian Public Works Department. It is not possible to describe, within the compass of one paper, the local peculiarities of even the principal divergent styles of house building in the different countries of India. The Maratha States round Bombay, although exposed to wave after wave of alien influence, possess an art of strong character, which, if not indigenous, is at least of respectable antiquity. I will go to them for my first illustrations, passing afterwards to a Persianised town in the Panjàb.

A Bombay House.

There is a strong family likeness between the intermural houses of the cities of Bombay, Surat, Broach, and Ahmedabad. In each, narrow frontages mark houses of the business centres; but in the maze of crooked streets behind the great bazaars, are found native dwellings, with spacious façades, which would be considered worthy of place in any of the great streets of European capitals.

I am sorry there are no illustrations here of entire fronts of the larger houses, which, placed in alleys, are impossibilities to photography; whilst the elaboration of their ornamentation defies any other means of representing their ten thousand points of light and shadow. The photographs grouped under the head of "Bombay Presidency" will confirm this statement. No draughtsman, however gifted and patient, could do justice to the representation of the whole front, of which the photograph I now show is a small detail. Such a front has the house of Mr. Kirpiram, of Surat, to whom I am indebted for the permission (refused by many others) to draw the interior from measurement. The section from front to back and plans of the three floors are the work of two Hindus, students of the School of Art, Bombay* (see plans pp. 734-5). Commencing with the ground plan, we first find the porch, which runs along the width of the house, and raised to the height of the plinth, five feet above the street. In other houses, this height varies from two to six above the level of the street. For the great width, it is shallow; still more so in some houses where the porch is but two feet deep. On the outside edge of the porch runs a curb of teak wood, upon which rests the row of stone bases of the wooden columns, with quaint bracketted capitals, which, in their turn, carry the heavy beam or lintel, the support of the whole upper part of the front of the house.

Some houses have no columned porch, but a small terrace, two or three feet wide and as many high, answers many of the purposes for which the porch is intended. Early in the morning, the men of the house assemble there, and, sitting on low stools, perform a part of the ritual of their toilettes. With brushes made from the twigs of the "babul" or "avalí," they solemnly scrub their teeth, intermitting the exercise with gossiping, giving instructions for the day to servants and clerks, and even transacting minor business. During the rains, the porch affords shelter to beggars, or people overtaken by heavy showers, and at night serves as a bedroom for servants of the house. Here travellers and houseless beggars are also allowed to sleep—a cheap charity to the giver, but a priceless boon to the recipient. The beggar in India is the rich man's guest, though self-invited, and no policeman dare direct him to move on. The principal door is in the centre of the porch. On entering this we come to a large and somewhat dark hall, called "othan" or "parsal," used sometimes as a store or lumber room; as a public office or "kacheri;" or, if the owner of the house is an artisan, as a workshop. In this hall any dying member of the family is brought, and laid down on the ground two or three hours before he breathes his last. During marriage

* Chiranjilal Doonichand, draughtsman, and B. A. Gupti, clerk to the school, directed by Mr. John Griffiths, superintendent and head master. The description of the house is taken from notes furnished by Mr. B. A. Gupti.

ceremonies, it serves as a ladies' receiving hall, and here, also, the servants of the house and lower class guests take their food. The rooms on either side of this hall have set uses. The one on the left, is generally occupied by the aged head of the family, when too infirm to ascend the step ladders which do duty for staircases. The principal staircase is situated near a door of this room, so that it may be watched by the patriarch, who notes all ascending it. In former days the armed servants of the house performed this duty, but now, under the security of the British rule, these picturesque retainers of the "good" old feudal times have disappeared. The room on the right side has its door in the courtyard, and in the house I am now describing, an entrance from the hall. It is used as a lavatory attached to the latrine. One side is paved and enclosed with a low wall, sometimes but a few inches high; here stand a row of water pots, from which the person polluted by having entered the latrine fills his brass vessel, and pouring the contents over his head, fulfils the rites of purification required by his religion. On the side of the hall, opposite to the street entrance, is a door of the same size, sometimes an open colonnade; through which the courtyard is entered. Beyond the courtyard are the women's rooms, and over it the broad balcony, which, running round at the level of the first floor, leaves but a comparatively small central space open to the sky. In small houses, the balcony is carried by beams, crossing from wall to wall, but here a colonade is necessary. The central portion of the courtyard, sunk some inches below the curb surrounding it, is paved and used as a general bathing place, well drained by a small gutter running to a cess pit, just below the front steps of the house. On one or either side are swings for the recreation of the ladies of the house; and here they pass most of their time, some swinging and singing to amuse the others who, sitting on the floor, labour at the interminable duty of sorting the cereals and pulses which form the staple food of the people. This, the wife's daily task, is performed with great care. A small quantity is placed on the polished surface of a low stool, every grain examined carefully, and separated from those broken and marked by insects. The corridor or covered passage round the courtyard is also used for the performance of the socio-religious ceremonies, such as thread, marriage, and caste dinners; here the family clothes are made, and the family jewels melted and remade by the "sonar." The staircase to the principal portion of the upper floor can be entered from here. It is seldom more than a step ladder, with a rope rail, which, in time of trouble, serves to haul it up. Under the stairs are cupboard-like compartments for the storage of records and books. One of these contains the entrance to an underground cell or "bhüyar," where the valuable property of the family is kept secure from fire as well as robbery.

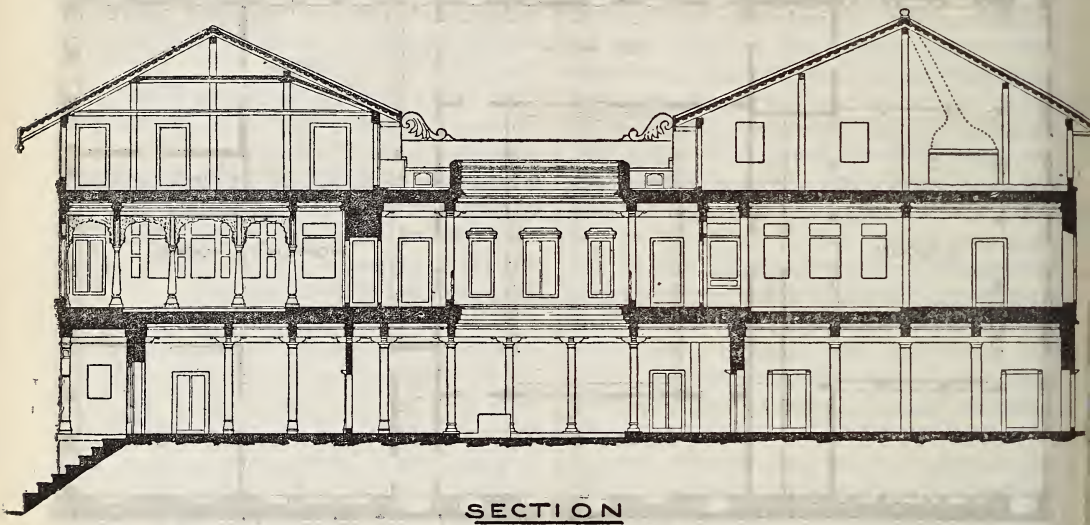
As in the present day there is little fear of violence, this cell is used as a cool room, for retirement during the hottest part of the day; it is always partly lighted and well ventilated by concealed gratings. In another compartment will be found a secret passage to another cell, the existence of which is known to the chief members of the family only.

Formerly "dacoities," or organised robberies, were very common in the Bombay country, and it is stated by members of the native mercantile class that bands of dacoits were frequently under the protection of the ruling princes. A gang would forcibly enter a house, and, securing the head of the family, torture him until they were satisfied that all his wealth was surrendered. In this case, the entrance to the first cell would be reluctantly disclosed, and the contents given up to pillage, while the other would still contain the more considerable property.

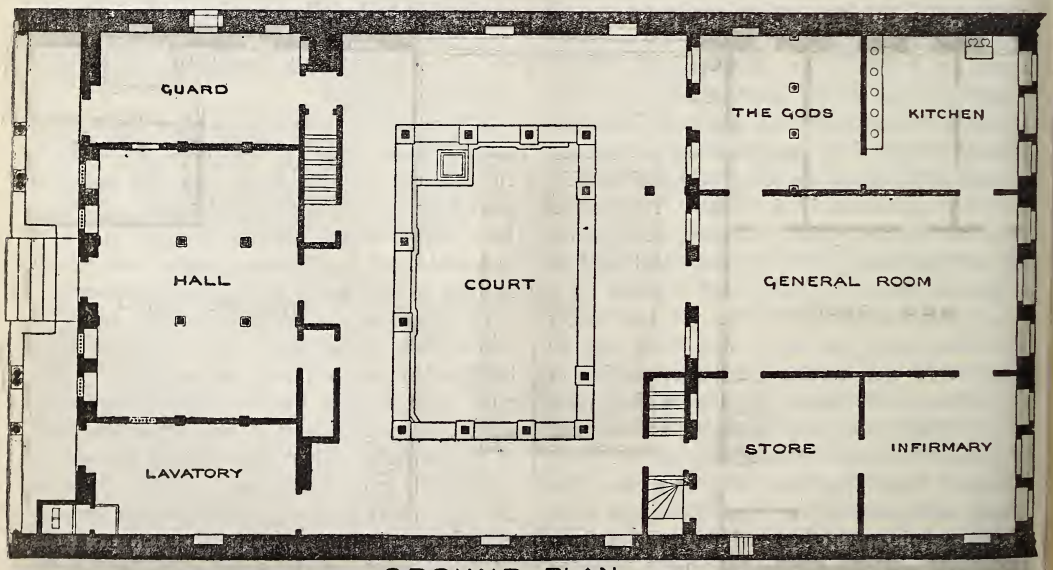
Before leaving the courtyard, a large stone mortar sunk in one corner must be noticed. In this the rice is freed from the husk by pounding with long ironshod wooden pestles. In a corner of the sunken centre of the court is a well-head, in this case over a tank, which is filled by rain water during the monsoons.

Leaving the cloistered court, we come to another hall, the women's room, where the wife, brothers' wives, and sons' and nephews' wives pass most of their time engaged in domestic work, in some houses under the superintendence of the owner's mother, who, during her life, is the chief lady of the house. To the right of this hall are two rooms, one for storing grains, the other an infirmary. The first room on the left is set apart for the worship of the family gods. It is furnished with a shrine, in front of which is a low stool or stone pedestal, for the use of the worshipper. On either side are stands for open lamps, and in the cup boards will be found quaint brass and silver vessels thirty to forty in number, as well as incense and different fragrant powders. Small niches in the wall contain the little lamps in which clarified butter is burnt during

the "puja" ceremonies. The next room is the kitchen, with a fireplace on one side. A raised stand of masonry runs along another side of the room, somewhat like a dresser, with a row of hollows on the upper surface, to hold steadily the large brass and copper pots containing the daily supply of water for cooking purposes. It is from two to three feet high, and the front is pierced with open arches, where the utensils of the kitchen are kept. Above on the walls are open shelves for storing spare cooking, eating, and drinking pots, all kept to a burnished brightness. From the ceiling hangs a swing-



SECTION



GROUND PLAN

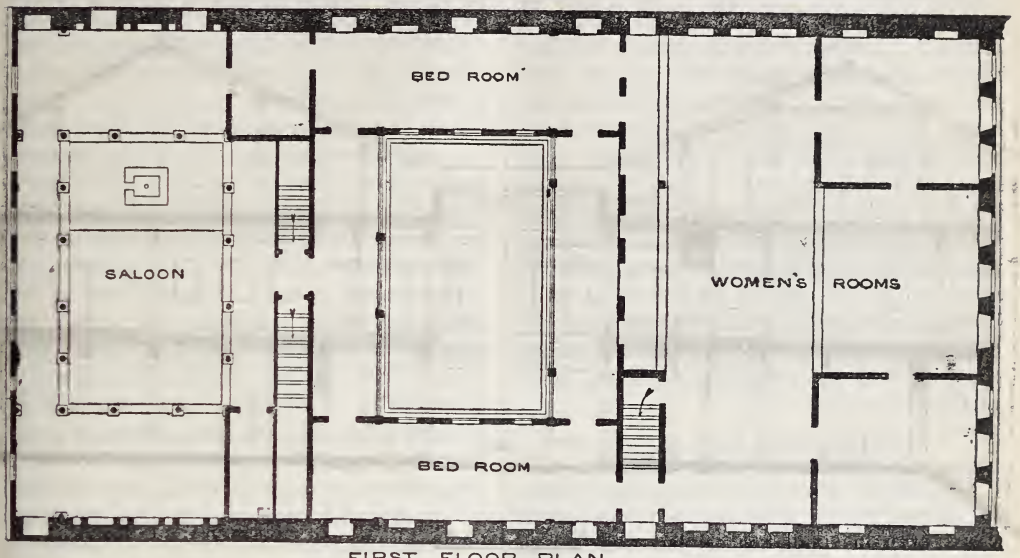
PLANS OF KIRPIRAM VEKIL'S HOUSE, SURAT.

ing frame, which serves to keep fresh vegetables required for immediate use.

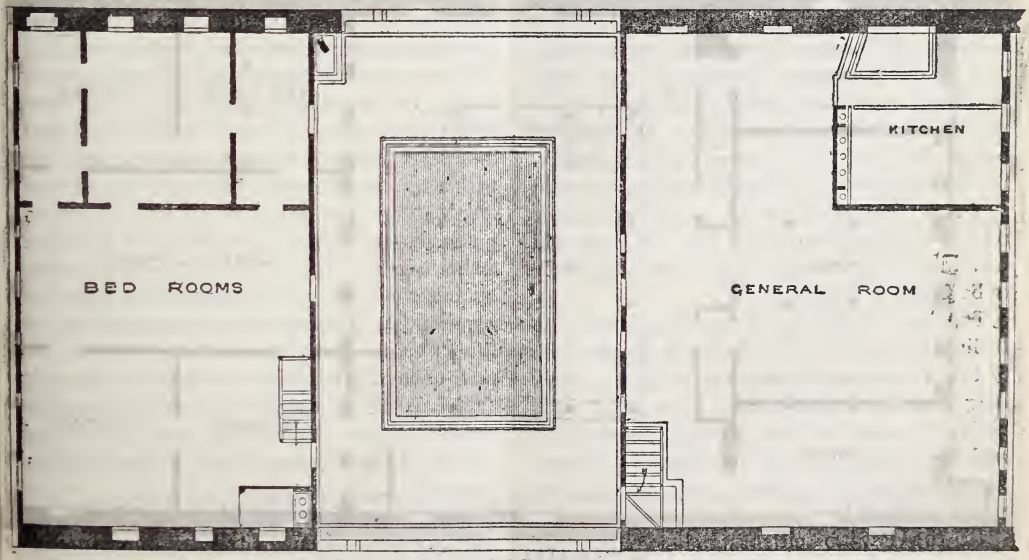
In larger houses there is still another court-yard behind the women's rooms; in this, an open yard separates the wood fuel store and stables from the residence.

On ascending the staircase already described, the balcony round the court is found to be partitioned off into rooms on two sides, leaving two open corridors which serve as passages, or, in certain seasons, for drying grains, and during the hot weather as bedrooms, when the moon

shines only. A central door leads to the principal room of the house, the divan-khana, or council-hall over the "parsal." An arcaded daïs runs round this room, raised a few inches above the oblong centre floor. This daïs is either carpeted or covered with a white cotton cloth over soft mats. Here, on great feasts, the guests sit and recline on cushions placed all round against the walls. In the centre portion, the travelling minstrel or religious bard, and



FIRST FLOOR PLAN



SECOND FLOOR PLAN

PLANS OF KIRPIRAM VEKIL'S HOUSE, SURAT.

the dancing girls with their attendant musicians, perform for the gratification of the guests and the glory of the giver of the feast; on one side of it is a fountain, fed from a cistern in an upper floor.

This photograph shows the hall as prepared for the reception of European visitors. Fortunately, at Surat, they are few. When the European chairs, tables, and couches, are removed for the next feast, if Mr. Kir-

piram could be induced to remove also the hideous looking-glasses and German coloured prints, the room would resume the stately look so admired in the halls of the princely palaces of India.

At the back of the house is another large apartment, where the ladies hold their "at homes." It serves also as a general sleeping room for the widows and unmarried girls; and here are kept the family stores of clothes in heavy boxes. The whole of the third floor has sleeping chambers with plaster ceilings, above which is the "mala," or space between ceiling and roof, used as a store-room. In this house one of these rooms has a cooking place with a chimney, and the usual stand for water-pots. The roofs slope inwards in small houses, and where the spring water is brackish, the roof and terrace water is collected, during the rains, into the underground cistern before mentioned.

A House in the Panjab.

Leaving Bombay, with its perpetual summer, for Lahore in the north, we find the central court, even in small houses, but modified to suit the exigencies of the colder winter climate. The style is also changed by the adoption of true brick construction instead of the trabeate building of Bombay, where the brick walls, though thick, are but the filling of a large wooden framework of column and lintel, which would stand of itself, and is often put together before the bricklayer comes on to the work. Such a construction will stand earthquakes and cyclones; but, if neglected, makes but a poor ruin, and therefore there are no very old buildings of the mixed wooden and brick style to be found in India.

The brick buildings of the Panjab seem to be lineal descendants of the brick architecture of the Tigris and Euphrates country. How long arch and dome have been used it is difficult to say, but both are well understood; and to this day the native builder will construct vaults of brickwork which only an engineer would attempt here.

In the Panjab cities wood is still used largely in house building, but not as an essential point in the construction, excepting where the space is insufficient for masonry. This you will notice in the three examples of shop architecture, one of which has but a frontage of eight feet, a space extraordinarily large in the eyes of the native landlord, who, in the next, has divided a shop, with an opening of but 9 feet 6 inches, into two by a stout wall, and carrying on his business as a pickle seller in one half, lets the other to a druggist. As these shops have no women's quarters, they are not properly "haveli," or dwelling-houses, but "baithak," or sitting places. I will therefore first describe the plans of a typical house, which has been prepared by Mr. Kipling, the able Director of the Lahore Museum and Art Schools, who has also prepared the other drawings from Lahore.

In the narrow streets—and in Lahore there are very narrow streets—many such houses may be found, though few will show as much frontage. In this house there is but little wood except in the doors and overhanging bay windows, which latter, in many houses, are entirely made of cut brickwork, even to the slender columns. Although the "deori," or entrance, is well proportioned, the strong prejudices of the Mohammedans in favour of seclusion have spoilt the open, hospitable look of the Hindu house. The hall opening at once into the ground-floor sitting-room, does not compensate for the loss of the vista through the cloister and court of a Bombay dwelling. Once through this room, which is the business room of the owner, the court is entered, and round the court are grouped rooms admirably constructed for protection against the great heat of summer as well as the cold of winter.

Here, again, Mohammedan influence is visible, for the stables, instead of being open to the court, are walled off; while the suite of rooms for business purposes on the upper floor, with a separate entrance in the street, and communicating with the court only by a narrow passage, or "gallé," are secured by doors at both ends. The kitchen is usually a small chamber off one of the open-sided rooms or alcoves, but in many houses, where cooking for the "bhaï" (brotherhood) is extensive, the row of mud and brick fireplaces, each only sufficient for a single pot, will be carried across a room. On special occasions cooking will be done anywhere, and a great display made of it.

Rooms are of several kinds and forms, but all show the influence of vaulted construction even when wooden floors are used. They are long and narrow, and, as a rule, in sets of three—a centre room in the form of a double cube, with an arcade or open verandah on one side, flanked by two small square rooms. When the centre room has a wooden arcade or verandah, it is called a "dalan;" when of brick or masonry, a "tindarri," or three doors. The small rooms are called "kotrís," and

are used as stores. This system of naming a chamber by its number of doors is common throughout all Mohammedan countries. The square pavilion, with three openings on each side, has given the name "baradarrí," or twelve doors, to palace buildings of different proportions in all parts of India. The upper floor is approached by two narrow staircases, and above, the court broadens by being carried over a portion of the lower story. Should the family, or rather families, increase, fresh rooms could be built here. This happens in a Moslem house by the bringing home of an additional wife; with the Hindu family by a marriage, such as that of the owner's brother's son, who lives with his relatives until he makes sufficient fortune to build for himself. On this upper floor the "baithak" is entirely separated from the "havelí" portion, which becomes a "zenana," or women's quarters. Above the arches of the two "dallans" are a row of rings, scarcely noticed by visitors to deserted houses. To these rings are suspended heavy quilted curtains, often handsomely-wrought with appliqué work, called "purdahs," or, where light and air are required, perforated blinds of split bamboo or reeds. The whole court is sometimes covered by a single cotton cloth, suspended about ten feet from the ground. This is a "shamiana," or sun-blind, often printed in good colours, with a rich border. A staircase leads to the upper terrace, which is, in summer, a general sleeping place for the ladies of the "zenana." Should the house be near others, a wall, at least five feet in height, will be carried round it, to prevent the occupants from being overlooked, or from overlooking. This wall is built with panels of honeycomb work, with the perforation running upwards in a slanting direction.

The chief difference between the architectural styles of Bombay and the Panjab lies in the façade, which, in the north, is broken by projecting windows, generally arranged in groups of three. When of wood, the forms approach those of the well-known "Mushrabeyehs" of Cairo houses; when in stone or brick, the window is but a slice, including three sides of a "chuttrí" pavilion with its dome, carried by a corbel of lotus flower shape. A window of this type, also the perforated wall of the upper terrace, is shown in Mr. Kipling's pen and ink sketch. The brickwork is excellent, the bricklayer seemingly trying to vie with his fellow artisan, the carpenter. Except when glazed, the bricks are cut and carved one by one, as wanted; often this is done after fixing. Moulded work does not seem to be known even to the glazed terra-cotta makers, who obtain their forms by rough modellings, and after the clay is dry and hard, finish with carver's tools. Samples of this brickwork are shown in these drawings, also in the photograph No. 11 of a piece of work at Amritzar taken before the jointing was covered up with plaster chunam.

I will now direct your attention to the drawings of three shops, all from actual measurement, by students of the Lahore Art Schools.

At a corner of the street in the Chatta bazaar, is a house with a frontage of fourteen feet, the return front down a narrow lane measuring twenty-five. The ground floor is raised above the street about three feet, and consists, at present, of two shops, with small store-rooms behind, and a staircase entered from a door down the lane. To make up for the smallness of shop front, a broad shelf at the level of the shop floor projects three feet, and being at the early stage of its existence, is supported by gibbet-looking brackets over the open sewer which runs close to the wall. The shelf has already acquired a verandah of two arches, and later on, when this is accepted by the authorities as an ancient frontage, an open panelled plinth will be carried down, and three feet of projection secured. On the first floor, the lane side becomes the principal frontage, and by bracketing out one window over it, and another over the bazaar, two good rooms are made, one 8 × 16, the other 10 × 12. These are separated by an arcaded partition, and can be thrown into one by sliding up the shutters in the two openings right and left of the door. The bay window over the bazaar is also separated in the same manner. A good example of this form of window is shown in photograph No. 12, the original of which is now erected in the South Kensington Museum.

On the second floor we come upon the court; here but six feet nine inches wide. There is but one good room separated by the court from a kitchen about six feet square, and a small bedroom or office 2 ft. 9 in. × 6 ft., possessing, however, a charming oriel window. Above these rooms is a terrace enclosed by a parapet three feet in height. This, on the bazaar side, is bracketed out, forming a central and two angle balconies. The three, raised a foot above the floor-level, are styled "shah nischin," or "king's seat." Here the owner sits for hours after sunset, and, when living in the house, spreads his bed. The

front is most minutely and elaborately ornamented in carved brick chunam and wood. The side pilasters and lamp niches are in carved brick. The three sets of panels over the shop are framed in wood and filled with mythological pictures, each with a pane of glass over it. The framework, columns, and arches of the projecting windows are of deodar cedar, the domes and corbels of chunam plaster. One dome, the largest, is an exception, being entirely of wood, this is unusual in Lahore, though common in the neighbouring town of Amritzar.

The next example of a "baithak" has a frontage of eight feet, with a depth of twenty feet. The planning is necessarily simple; below, there is the usual shop with storeroom behind. On the first floor, a single room, convertable into two by closing the doors of a partition, and enlarged by bracketing two feet over the street. The second floor has the inevitable court or terrace, leaving but a room of four feet six inches by eight feet, and staircase to the small terrace above. Still smaller frontages can be found; five feet is not uncommon.

House Building Customs.

Turning from the houses to their builders, I will select some notes on house building customs, folk-lore, &c., from a valuable mine of information, placed at my disposal by Mr. Kipling, who for twenty years has been in constant communication with the most interesting, and, in my opinion, the best people of India, the artisan classes.

The native prefers looking after his own work. Houses are seldom built by contract. Those built in cantonments for Europeans are sometimes given out to contractors; but the native house proper is the enterprise of the owner. He engages a "mistri," who is at once architect and clerk of the works. Materials are purchased by the "mistri" and the owner, or his agent or servant in company. Wages are paid to common labourers daily, and to craftsmen at irregular intervals. The accounts invariably get complicated, by reason of advances, and what a London tradesman calls the "dead horse" is never fairly worked off. When any difficult work is in hand, or a spurt necessary, the workmen are treated with tobacco, sherbet, or sweetmeats. One "mistri" will sometimes have two or three houses building at once. Scarcely any drawings are made; there are designs extant, but they are seldom drawn to scale. Once begun, the work goes steadily on, and no notice is taken of the many holidays. Rain only stops it.

When a Mahommedan starts a foundation of a house, he gets an auspicious day fixed—as often as not by a Brahman—and the ordinary Hinduised Mahommedan of the eastern district will entertain Brahmans at a dinner. A strict Mahommedan will get a moollah, or respectable man of weight and character, to lay the first brick; he distributes goor (sugar) to the poor, or gives a dinner. And when the house is finished, he gives an "inam" of a shawl, or a turban, or money to the "mistri."

Very orthodox Hindus will sacrifice a goat at the beginning of a house, and "Ganesha," the elephant-headed god who presides at all beginnings, and whose quaint figure finds a place over most Hindu doorways, is worshipped. His sign heads every baniah's account-book, and is the ubiquitous "swastika," or cross fylfot of our heraldry. Some earth from the parental homestead is often interred with the new fonndations, or placed in the pot of the sacred "tulsi" plant.

When the house is finished, or at a convenient time after, an auspicious day is fixed for the ceremonial entrance, or "juth khana," the house warming. A "ghurrah" of water is first sent to the house. The owner, with his wife and family, the family priest (purohit), with their friends, make a formal entry. Sometimes husband and wife go in their "chudders," tied together as on their wedding-day, but this is by no means an invariable custom. Then the great powers are worshipped, "Ganesha," for prosperity; "Saraj," the sun; "Chandia," the moon; "Agni," fire; the "Nag," serpent, for protection (?); "Koomb," water; and the "Tirshool" (probably "trisul," the Trinity). Then there is a formal ceremony called "hamun," a sort of fire-worship.

Brahmans are feasted, and their friends and relatives. The "mistri" attends the dinner, and receives from the owner complimentary gifts, such as shawls, turban-cloths, money, as his merits and the generosity of his employer dictate. They have often awful times together, like employers and architects all over the world; but on this day they bury the memory of extras and disputed accounts. There are, of course, hardened Anglicised Hindu folk who slur these ceremonies, and neglect to give the good god "Ganesha" his due. During the building of a house, a lamp is often kept burning all night. This prevents any of the numerous host of "bhuts," "churels,"

and the like, ghosts and demons, from taking up a lodging in the new abode.

Somewhere in front of most houses a "ghurrah" water-vessel, painted black to counterfeit iron, is slung. This is a "nuzzer waltoo" (phonetically), a sovereign charm to avert the evil eye of envious folk. By right, the "nuzzer waltoo" should be iron, but fate is proverbially blind, and easily taken in. In the Karnal district, when the house is finished, the young daughter of the house ties to the lintel a "kaughna" amulet, consisting of an iron ring with other charms, and the father gives her Rs.1 4a. for doing so. A Hindu likes a house that is cow-mouthed (gao-mukha), wider behind than in front; and a tiger-mouthed one (shér-dáhán), wide in front and narrow behind, is not considered so lucky.

Generally, in districts with increasing prosperity, brick is taking the place of "adobe." In the cities the price of wood forbids the extensive use of wooden balconies, &c., that once prevailed. The door or window-frame is often wrought separately, sometimes in another town, and though it may appear to be set in the expanse of brick-wall in a chance-hap sort of way, frequently has an effect which more studied designs miss; naturally, a deeply-recessed, well-carved door or window-frame can scarcely come amiss anywhere.

Some backs of houses, in their unstudied simplicity, with openings occurring irregularly in the great surfaces that follow unexpected turns and angles, are quite as interesting as the formal fronts. But their charm is not easily translatable. A vast sweep of brickwork, pierced here and there with an opening, filled with perforated terra-cotta, or jewelled, so to speak, with a carved balcony, or a bit of painted wall, whose tiny details give an air of space and size by contrast, looks quite splendid in the sunlight, but it is not easy to draw it successfully, and it was never in any strict sense designed, but grew in an organic and altogether inimitable fashion.

In some districts there is a quaint custom. When a carpenter has made a particular good "chanleat" door or window-frame, he takes it to the house into which it is to be built, and spreading a sheet on the ground, he lays his work down, and sets himself alongside to receive the congratulations of his townsfolk. These take a practical form, and cowries, pice, and white money rain on the sheet. They say that once as much as a hundred rupees testified to the skill of a carver. But this is unknown in the large cities.

Since it is unlucky to start but with the left leg, some "mistris" say steps should be odd numbers, so that the left comes first into the upper room; but this is not constantly observed. The risers of native steps are always high and awkward. At Jeypore they go up slopes instead of steps.

Apprentices learn more by practice than precept. No native likes to give downright straightforward instruction, but makes as much of a mystery of things as he can. The small boy, when he is not pulling at one end of a saw, melting glue, fetching tobacco or "pán," or doing, as he sometimes does, the full work of a man, sits in a corner with a wooden tablet on his knee, about the size of a school-boy's slate. In the corner, the "ustád," or master, sets him a copy, and, with a reed pen or a brush made of squirrel tail hair, he copies a flower or spray, doing it over and over again, till he can almost do it blindfold without erasure.

These two sketches, measured and drawn to scale, of late Sikh brick and plaster work, is from a sort of tiny monastery, or retreat of Sikh holy folk. The place is "Chajju Bhagats Chobara," and although the work is small, it gives a fair idea of the brick design of to-day. The gate looks better in the original than in the drawing, and the thin, clean cut mouldings of the arched wall, which goes round a brick court, enclosing some fantastic domed shrines elaborately painted, looks better in the sun. Sher Mahomed's elevation of a modern door in Dhamon-ki-gallé, shows the arrangement for getting the honour of a porch in a narrow alley. Here is a pen-and-ink drawing, by Mr. Kipling, of this alley, with Sher Mahomed's door on the left, and a purely brick front in the background. This may give a notion of the quaint irregularity of alignments, and the exceeding narrowness of the alleys, in the great honeycomb of brick composing Lahore city. Observe, opposite Sher Mahomed's door, the wooden step made to pull out like a drawer, and the plastered "tharrah" under the window in the left front. These "tharrahs" or stoops are a constant source of trouble and litigation.

As in Italy, so here, the women folk, who stay at home, fish up their purchases from the street, from a hawker, or the boy, or old woman who goes to market for them. The basket is frequently slung by the side of the window in readiness, as in the sketch. The open work above is terra-cotta. These perforated screens are the only decorated architectural work

wrought in soft clay, and they are not moulded. Everything else, lamp niches, with the most delicate work, are carved in burnt brick. The opening above the window in the left front is filled with a lattice of hoop iron. Another pen-drawing is from Mishr Boli Ram's "gallé," and shows a narrow painted front. The house goes on widening behind. The terra-cotta open work at top is set in plastered work, and the chunam has weathered to a fine black grey velvet. The fairies over the window have faded, and so has the pattern on the wall face, under the moulded chunam corbel of the bow window; modern as it is, however, this front, and the bit generally, is very pretty. Two of the youngest of the Lahore students, Goordet Sing and Moula Baksh, have sent sketches of a window "chankat," or rather "bari" and a door. From sketches like this, it may be realised how the door and window are frequently in modern work (it is probable in old, too) separately wrought and worked in anyhow.

I have now but described two styles, and the limit of my paper being near, regret that notes on other localities must be left for the future. Every great division of India could contribute something to our store of information, and if as much were done to investigate and preserve the living traditions of Indian handicraft as is now devoted to the more speculative work of archæological research, we would be soon in possession of the key to much puzzling matter, both in the arts, social relations, and politics of the people of India.

DISCUSSION.

General MACLAGAN, R.E., considered that the paper was not only most interesting in itself, but was novel in its nature. They had all, no doubt, heard the architecture of India spoken of, but it was that class of architecture which appertained to great and ancient buildings, to which, as the reader of the paper had said, a great amount of attention had been paid, but nothing had hitherto been said as to the ordinary domestic architecture of India. What might be particularly noticed with regard to these native Indian houses, was the convenience of the interior arrangements considered with respect to the climate of the country. He had had occasion more than once to live in native houses, and could certify that their general convenience and adaptability to the climate was very marked and satisfactory. One other thing which was also worthy of notice, was the tendency on the part of the people to exhibit some kind of ornamental work, however small or rude it might be, on the fronts of the houses, which tended greatly to beautify them and render them artistic. Of this they had an illustration in the model before them, and when that part of the exhibition at South Kensington dealing with this class of architecture was completed, he was certain that it would form a subject of very great and unusual interest to the people of this country, who, so far as he knew, had no opportunity previously of getting information on this matter.

Mr. GANGA RAM said he should have been better prepared to make some remarks, if he had had an opportunity of studying the paper beforehand. The domestic architecture of India, however incomplete it might look to the eyes of Europeans, was certainly adapted, as General Maclagan had just now remarked, to the climate and the convenience of the people; still there was no doubt there were many knick-knacks which could be introduced into the buildings, which would tend greatly to the comfort and convenience of the people. He had only arrived in this country a few days ago, but, from the little experience he had had in that time, he could certainly see many things in European buildings which it would be to the advantage of the natives in India to have in their buildings; and, on the other hand, there were many things which could usefully be introduced into this country from India, and especially with regard to the exterior appearance of our buildings. The author of the paper had made some remarks with reference to the separation of two rooms, in a house at Lahore, by an arcaded partition, by means of which partition these rooms could be thrown into one, "by sliding up the shutters in the two openings right and left of the door." These shutters the speaker considered were very inconvenient to lift up and pull down, and he thought that they could be much more easily managed by a small pulley and weights and cords, as in this country, and he wondered the idea had never been suggested.

The CHAIRMAN thought that if cords were used in India, they would soon be eaten away by the white ants.

Mr. GANGA RAM, in resuming, explained the reason of the Hindoos preferring cow-mouthed, or narrow-fronted, to tiger-mouthed, or wide-fronted, entrances to their buildings. The Hindoos, every one knew from past history, were at one time a civilised nation, and all their habits and customs were really based on some reason; and though perhaps they had fallen into ignorance, as compared to their former state, there was no doubt that all their customs would be found to have their origin in some earlier time, and to have been handed down to them in the form of religion and in other ways. For the convenience of the Hindoos it was necessary to have a courtyard in front of the house, consequently, if the entrance were tiger-mouthed, all

the space would be taken up by the courtyard in the front, and there would be no space left at the back. For other reasons also, it was more convenient to have a cow-mouthed entrance; for instance, it afforded more light to the occupants.

Mr. BALMOKAND quoted various parts of the paper, pointing out what he considered to be errors on the part of Mr. Purdon Clarke as to facts. For instance, the words "shah nischin," which he had stated meant "king's seat," also meant in Punjâbi "the owner of the house;" and what had been referred to in the paper as the king's seat, was in that province really only the place where the respectable members of the family sat. Then as to the statement with respect to the houses being surrounded by walls seven feet in height, he could positively state, from personal knowledge, that in the Punjâb the walls were never higher than five feet.

Mr. ALEXANDER PAYNE, as an architect, wished to be allowed to express his opinion as to the beauty of the drawings and photographs which were exhibited round the room that evening, and he believed very few people in this country were in the least aware of the amount of beauty there was in the houses they represented, and that the subject of the paper they had heard would be accepted by everybody as a new and interesting one; and he had no doubt that if Mr. Purdon Clarke could embody those drawings with some of his notes, more elaborated, in a book, such a work would find a great reception amongst architects in this country. He would like to ask Mr. Purdon Clarke one or two questions as to the buildings. First, he should like to know whether these buildings, of which they saw photographs, were all modern; or over what range of years they extended?

Mr. PURDON CLARKE said they were mostly modern—some of them were, perhaps, two hundred years old, but many of them were not twenty years old. Several of them (which he pointed out on the wall) had been built in a place which had hardly been yet named, and the streets in which did not exist five years ago; and these houses now appeared to be old.

Mr. PAYNE remarked that it appeared to him then that there was a very large amount of able carpentry to be drawn upon in her Majesty's dominions, of which hitherto he was totally unaware. He should be glad if Mr. Clarke could give them some information as to the drainage and water supply of these towns in India.

Mr. PURDON CLARKE said that that would be rather a long subject, but he might state shortly that as to drainage, they simply had none. He was in India when cholera was very bad in the Panjab, and he thought that it raged quite as fiercely in the European quarters, which were four or five miles away from the dense part of the city, as where the natives were thickest. As a rule, he thought that cholera and typhoid fever generally followed on sanitary improvements. They would see by one of the drawings on the wall the whole system of drainage shown. A trench was dug down a street, and a small trench dug from each house to it, and there they had the whole system. Where the sewage went no one knew or cared. The trench went from street to street all over the place, but where it ended no one could tell.

The CHAIRMAN said it ended in the sun, which soon sucked up all the ordure.

General ST. CLAIR WILKINS, R.E., said as a rule the European in India knew very little of the domestic architecture in that country. He passed down the streets but never thought of going into one of the houses to see what they were like, but, at the same time, he always admired the details that he saw, although those details and the buildings themselves were on a very minute scale as compared with our ideas in this country. Referring to the model upon the table, he thought they would see that it was a very small building as compared with ours, but the beauty of it was undoubted. One of the native gentlemen, who had spoken that evening, said that his country had departed from its state of civilisation of former days, but he, the speaker, must differ from him in that respect. It was impossible to see these beautiful buildings in India without admiring the ingenuity and skill with which they were designed and carried out, and the Hindoo was certainly far in advance of the people in this country in that matter. One might go through villages and towns in England, and in nearly every place one went, one was almost sure to see the most hideous structures imaginable. For instance, what could be more unsightly than the village church, with its square tower of no type, and its walls pierced with windows of different periods. In India all the buildings were filled with the most delicate details. He had often asked his building friends in India, how such buildings were erected, and the answer was—"Oh, in those days, there were no plans or estimates, the rajahs and chiefs used to spend all their money in erecting these buildings, and they never thought of the plans or the cost." He should be glad if Mr. Purdon Clarke, at some future date, would give them a more extended view of the architecture of India. However small a house might be, its windows and doors were designed and cut in the most artistic way. He had admired for years a small window at a certain spot in India, and on one occasion took the opportunity of inspecting it, but it was so small, scarcely three feet high, that he could hardly get into it, but the beauty of it was very great indeed. The houses were, however, erected of very flimsy materials, in fact, in Bombay, they were built of timber, and perhaps filled in much the same way that London

builders build their houses inside; they could not, therefore, expect them to last long. He thought that if these drawings could be put into some form, so that they might be made available for the architects in England, that they would be well studied in all their details. The authorities of the South Kensington Museum were doing a good deal in this direction under the efficient auspices of their Chairman. The architecture of the larger buildings in India had not been treated on, and, therefore, he would not say anything on that subject.

Mr. W. MARTIN WOOD said some of the plans shown in detail, together with Mr. Clarke's description of the relation between different portions of Hindu dwellings, reminded him of a remarkable paper on the same subject that appeared in the *Indian Antiquary* about seven years ago. It was written by Dr. Kerns, a scholar and missionary well known in Southern India. He showed that every part of the plan and each important detail was settled by religious sanction, and evidently brought down from far-off prehistoric times. He was very glad to see the ample recognition which was given in the paper to the merits of an old friend of his, Mr. Kipling. Their chairman, Sir George Birdwood, knew him in his rising days, when he first taught sculpture and modelling in the Bombay School of Art, which had yielded such good results, as Mr. Clarke had shown. He (the speaker) afterwards knew Mr. Kipling in his time of maturity when, the work which he had done being recognised by the people in the north of India, the friends of Lord Mayo secured him to become the originator and organiser of the School of Art and the Mayo Museum at Lahore. Referring specially to the perforated wood carving, of which so much was seen in India, he said he was reminded by Mr. Clarke's illustrations of the Collector's house at Dharwar. There were there a number of windows of perforated wood which had been brought from the palace of Chittore, a place twenty or thirty miles away, which they would remember was at one time the scene of a conflict, when the fort was carried by storm. They would know numbers of instances of that kind where these splendid pieces of carving were brought away from one place to another, and incorporated in new buildings, but the architecture was done in such a skilful manner that it was almost impossible to tell that they had not formed part of the original structure. He trusted the attractive exhibition placed before them would induce professional architects and others to study the whole subject in the Indian department at South Kensington.

The Rev. J. LONG inquired if Mr. Clarke was of opinion that some of the details of the architecture of India might be usefully adopted in this country, as we were so overrun in the present day with horrid structures, erected by jerry builders, that any improvement would be a great boon.

Mr. CLARKE replied that he would not advise English people to orientalise their houses. The only point he had noticed as being of advantage was one with which we were already provided in our Gothic houses, namely deep bayed windows.

Mr. JULAND DANVERS hoped that Mr. Purdon Clarke would continue to instruct the people of this country with regard to the results which he had obtained from his recent tour in India, and that they might have further opportunities of hearing from him what he had learned. He (Mr. Danvers) thought it would be a great mistake to depart from the ancient styles of architecture which were found in such perfection in India. Nothing could be so attractive as the beautiful effects that were produced, and the details which were to be seen in many of the old buildings there, and he could not help thinking that the Anglo-Indian architectural attempts in India, until very recently, had been lamentable failures, and that nothing modern had yet come up to the perfection which was observable in ancient buildings. At the same time he considered that, while we in England might be very much improved in our tastes by what we learnt from the Hindoos, those who, like the native members of the Public Works Department here present, have come from India for the purpose of seeing the effects of European skill and workmanship, may receive many hints which would really be useful in the construction and arrangement, whether internal or external, of domestic buildings in India. He could hardly agree with the opinions which he had heard expressed, that there was nothing to be learnt from the usages and contrivances, and the combination of science and art, to be seen in this country.

Mr. VINCENT ROBINSON wished to know if there was in force in India any Act equivalent to the Building Act in this country, and whether, under the provisions of that Act, in some parts of India, they were doing away with overhanging balconies.

Mr. PURDON CLARKE said there was a Building Act in force there, applying only to large cities, prohibiting people from building over the street. It was attempted to bring a similar Act into force at Lahore, and it almost passed the Municipal Council, but some members of the Council interested in Indian art managed to get the natives to protest against it, and after a correspondence with the Government, it was withdrawn, and they were allowed to build balconies, and in many ways to do as they like with regard to the erection of their buildings. In Bombay, where the Act was in force, the new houses were the ugliest houses in India, and if such an Act became general throughout India, the class of buildings represented in the photographs and sketches would be doomed.

Mr. PEDDER was disposed to agree with their Indian friends that there was something to be done

in the way of practical improvement in Indian architecture. He had lived in a good many houses in India, and he certainly thought that when there was a hot wind blowing, as occasionally happened in the month of May, one would be more comfortable if the window would shut, which no window he had seen in India would do. They might have their artistic advantages, but they would not shut, and would not open, and he thought, on the whole, it would be better if they did. He knew a good deal of Bombay and Ahmedabad, and no doubt the appearance of overhanging balconies was very artistic, but from a sanitary point of view they had disadvantages, and he had, in his official capacity, refused to allow their erection. With regard to sanitary matters, the reader of the paper had explained to them (and he had himself seen it in many parts of India) the system of street drainage, and he (the speaker) believed that the system was not so bad; but there were a good many towns in India, Surat was one, in which there was the practice of every house having its own cesspool, and a worse practice sanitarially could not be conceived, and any system by which that could be improved would, he thought, be of advantage.

Sir GEORGE BIRDWOOD, in moving a vote of thanks to Mr. C. Purdon Clarke for his interesting and valuable paper remarked, that what most impressed him was, the obvious similarity of the ground plan of the houses described by Mr. Clarke to that of Greek and Roman houses. It was, of course, to be accounted for partly by the fact that the Greeks and Romans were offshoots of the same primitive Aryan race as the Vedic Hindus who entered India about 3000 B.C., and becoming mixed in ever increasing proportion as they moved eastward and southward with the pre-existing Mongolian, Kolarian, and Dravidian races of the country, had formed there the race of Brahmánical Hindus. The history of civilisation was the history of the migration of the Aryan races, and the vicissitudes of civilisation had been due to the exposure of the line of Aryan migrations westward, particularly in Anterior Asia, to constant irruptions of nomad Turanians from the north, and nomad Semites from the south. When Aryan civilisation was through several succeeding centuries attacked in Europe and in Persia by mixed Turanian and barbarous Aryan hordes from the deserts of Central Asia, and by the Saracens from the deserts of Arabia, ancient history was brought to an end in Anterior Asia and Southern Europe, and the modern history of Christendom and Islam began. In India, however, partly because it was out of the direct line of the westward migrations of the Aryans, and of the direct lines of the secular irruptions of the Turanians and Semites, and partly because it was guarded by the Himalayas as a garden by its wall, but chiefly because of the strong religious organisation given to Hindu society by the Code of Manu, ancient history had continuously survived to the present time; and that was one of the reasons why we were reminded every day in India of Greece and Rome. Mr. Clarke had mentioned how, in India, when a younger branch of any family founded a new house, some earth from the ancestral homestead, generally a pot of the sacred basil or Tulsi plant (*Ocymum sanctum*), was carried to it. Now Plutarch tells us that when the city of Rome was founded, Romulus and each of his companions threw into the trench dug for the foundations, a handful of earth brought with them from Alba Longa; thus connecting Rome with the country of their forefathers. In India, as in Rome, it was a rite connected with the primitive ancestral worship of the Aryan race, on which, in India, the Brahmanical religion was engrafted; and still, in India, the obscure primæval family gods, the deified ancestors, symbolised by the *salagrama* and the *lingram*, were adored with a far deeper reverence than the wider known idols of the Puranic Pantheon. This was the simple cause of the profoundly interesting agitation which recently prevailed in Bengal, on account of one of our Judges having insisted on the production of a *salagrama* in open Court. Of course the Penates cannot be forcibly removed from the domestic penetralia without outraging the strongest and most sacred feelings of those who, like the Hindus, believe in the divinity of human families. The worship of the Tulsi, which has had its effect on the domestic architecture of India, was also, as he had before pointed out in these rooms, intimately associated with ancestor worship in India. The sacred hearth must rapidly have disappeared as a feature of the house in a hot climate like India. For cooking purposes it was replaced by a separate cook-room, while, for certain portions of family worship, it was replaced by the altar of the Tulsi plant, which was either built up in one of the inner courts of the house, or, in houses without courts, in front of it. In houses which had neither courts nor front gardens, it was replaced by a simple pot of Tulsi, set or hung in one of the front windows. The *salagrama* was always kept between two Tulsi leaves fresh cut every morning and evening, and it was to be observed that the *salagrama* was the only thing of the kind in India which derived its deity from itself, and not from consecration. But India was like Greece and Rome, because also they re-acted on it; and the inspirations of classical culture were felt in India at a much earlier time than was commonly apprehended. The conquests of Darius in India were really Greek conquests, not merely in the sense that Persian civilisation from the time of Cyrus—who, by the strong organisation he gave to the empire founded by him, excluded the Turanians from Anterior Asia for centuries—had rapidly become Hellenised, but that they were actually directed by Greeks, like Scylax, for instance. We know further that the revolted Greek colonists of Barca were settled by Darius, 200 years before Alexander, in a village of Bactria, which they still called Barca in the time of Herodotus, B.C.

481—*post* 431. Again, as Strabo tells us, the priestly Greek families who betrayed the temple of Apollo Didymæus to Xerxes, accompanied him on his retreat to Persia, and were settled by him in Bactria, in a village which they named, after their Milesian home, Branchidæ, where Alexander, 130 years afterwards, found their descendants still speaking Greek, and ruthlessly massacred them for the treachery and sacrilege of their ancestors. Herodotus also mentions the removal of the Pæonians to Asia Minor, of the Milesians to Ampe at the head of the Persian Gulf, and of the Eretrians to Susiana. And in these heroic transplantings of nations, the Persians but followed the examples of the Assyrians and Babylonians before them. We learn from Arrian that Xerxes also carried away from Greece, and deposited at Babylon, at Pasargadæ, at Susa, and other cities of Asia, the statues of famous men, and of the gods, and the artistic vessels used in the worship of the gods, for which Alexander caused special search to be made when he was in Persia, and so suceeded in recovering the statues of Harmodius and Aristogeton, belonging to the Athenians, and the brazen image of Artemis of Cercæa [? Agræa]. Such facts as these were of the most suggestive significance in the history of art, and many of those present would at once recall how in the Bible, where the deportation of the Jews to Babylon by Nebuchadnezzar is recorded, it is expressly added that he carried away with him "all the craftsmen and smiths." The captivity of the Jews in Babylon, and of the Israelities in Assyria, were indeed intimately connected with the development of commerce and the diffusion of the arts in antiquity. The Israelites were never lost—none of their masterful race ever lost themselves in this world—but spread themselves all over Anterior Asia, where their lineal descendants remained to this day. As for the Jews, only the fanatics and vagabonds ever returned to Jerusalem, and the best part of them remained in Babylon; where, through their participation in the great trade which, since Psammetichus, in the seventh century B.C., threw the ports of Egypt open to free trade, had been growing up between the East and the West, they fully developed those remarkable natural capabilities for commerce which had ever since secured them their ubiquitous hold on the finances of the world. The diffusion of the Jews in this manner in universal commerce must have exercised an immediate and immense effect on Persia, Arabia, and India, and indeed, on every country with which they, with their uncompromising monotheism, and pure domestic life, and exalted hopes in a coming Messiah, were brought in contact; and it was probably one of the chief secondary causes of the more spiritual views of the nature of man and of his destiny, which began, with the free trade established by Psammetichus, to prevail about this period over almost the whole ancient world, and which at last found its highest and most practical expression in the teachings of Christianity. But, returning to India—Bactria, which was conquered by Alexander, B.C. 329, remained under the Greek rule of the Seleucidæ for nearly 70 years, and continued under independent Greek rule for about 120 years more, when it was subjugated by the Saka-Scyths or Sacæ, *circa* B.C. 140—130. Even after this the Græco-Bactrian settlements on the Indus flourished for another 100 years, bringing us nearly to the Christian era, when (*circa* B.C. 15) they also were overthrown by the invasion of the Tukhara Scyths or Tochari. But the Indo-Scythian kingdom, founded by Kaniskka, so far from counteracting, actually reinforced the Greek influence on India of the Græco-Bactrian settlements it replaced. Its dominion extended to Central Asia; its power was felt all over India, and its fame reached to China and to Rome. It flourished coincidently with the supremacy of Buddhism, as the state religion of India B.C. 250—A.D. 429. The Roman Empire had reached the limits of Augustus, China had become united under the Han dynasty (B.C. 206—A.D. 9), the Andhras (B.C. 31—A.D. 429) in succession to the Mauryas (B.C. 325—118), and the Kanwas (B.C. 118—31) ruled all over eastern India. The Cheras, Cholas, and Pandyas still ruled in the extremity of the Dakan; while the great Vikramaditya, if there was any truth in the Brahmanical legend of this king,* had founded a powerful dynasty in Malwa, and, a little later, Salivahana in Maharashtra. It was under these favourable political conditions, and owing also to the most opportune discovery by Hipalus, A.D. 47, of the secret of the navigation of the Indian Ocean by the monsoons, that the ancient commerce between Europe and Asia now at length obtained its fullest expansion; and, from the age of Alexander (B.C. 356—324-3 at least), it proved the most powerful agency for the spread of Greek and Roman, *i.e.*, of classical culture, throughout the Old World. It was true that Parthia had revolted from the Seleucidæ in the same year as Bactria (B.C. 256), and that henceforward Persia remained under Parthian domination until it regained independence under the Sassanidæ, A.D. 225–26. But in Persia, as in Bactria, so strong was the impression made by the culture of Greece, and so fully was it sustained by the commerce of the time, that the Scythian conquerors of this archaic Aryan country were also rapidly Aryanised. Every circumstance, therefore, during the rise and continuance of the Indo-Scythian kingdom, tended to augment the commerce which had been slowly growing up between the Mediterranean and the Indian Ocean, ever since the reign of Psammetichus, and, as a direct consequence, to perpetuate in India the civilising influences of Greece and Rome. They had an immediate effect on the literature, the science, the religion, and the arts of the Hindus; but the most remarkable proof of their

*. I sometimes suspect that the legendary Vikramaditya is partly Augustus Cæsar, and that "the nine gems" of his Court are partly our familiar friends, Virgil, Horace, and their contemporaries.

former universality and power was the antagonism shown to them, and the foreign commerce which everywhere propagated them by the Brahmans, as elaborately formulated in the Code of Manu. It was a satrap of Kanishka's who founded the Sah dynasty which ruled in Kathiawar and Kachh, from about A.D. 50—60 to A.D. 400—405, when it was overthrown by the Guptas of Kanauj. It was one of the viceroys of the Guptas who A.D. 480, founded the Valabhi dynasty of Kathiawar, which, as the Guptas passed away from the Indian history, extended its dominion over Kachh, Lata-desa, or Khandesh and Malwa. If, as was generally presumed, the mysterious Guptas were of Greek origin, it might even be said that, under one form or another, Indo-Greek dynasty held sway in India nearly to the sixth century, A.D. The Greeks we know continued to trade in the Indian Ocean to the reign of Justinian A.D. 527—565; soon after which the Mahommedans began to overrun the Old World, and made an end of ancient history in Anterior Asia. The Valabhis appeared to have suffered from a Persian invasion in the 6th century A.D., and again from an invasion of Arabs in the 8th century, but they were not finally driven out of Saurashtra by the Mahommedans until the 14th century, and thus they might be said to have maintained the direct tradition of Greek rule and Greek art in India down to the dawn of modern times. In short, from the reign of Psammetichus to the first invasion of India by the Mahommedans, that was from the 7th century B.C. to the 7th century A.D., during which period the ancient commercial intercourse between the East and the West was continuously active, and Buddhism rose, culminated, and declined in India, and the Scyths lorded it for a thousand years over the plains of Hindustan, the more or less direct influence of Greece on India was unbroken, and it lingers there to this day as a latent force. Owing, indeed, to the stability given to Hindu society by the Code of Manu, the long series of ethnical convulsions which ended in the destruction of the Roman and Persian empires had little more than their political effect in India, and but for the deterioration of the Aryan race in India, particularly in Bengal and the Dakhan, through its admixture with the Mongolian, Kolarian, Dravidian races of the country, Greek art might have been maintained there to this day in something of the purity which characterised it during the times of the Athenian, Spartan, and the Theban supremacies, and the age of Alexander. This was not to be, and therefore when, one after the other, the Western, the Persian, and the Eastern empires fell before the onslaught of the barbarians from Central Asia and Arabia, the regular evolution of Aryan civilisation in the Old World was for ever arrested. The genius of the race rapidly reasserted itself, and in the West gave rise to Gothic art, and in the East to Saracenic art. They, however, sprang up as a new growth from the ruins of the Aryan art of the old Roman and Persian world, and were, moreover, devoted to two radically alien religions. In the Eastern, or Byzantine empire, indeed, the transmission from Pagan to modern Christian art was more gradually effected, only there, unfortunately, classical art, owing to the reaction on it of Persian and Indian art through the overland trade with the East, had already been debased as low as centuries before in Parthia and Bactria. But if the Hindus, owing to the stationary character of their theocratic society, had had little part in the advancement of art, except perhaps in its archaic beginnings, and seemed incapable of the practice of the fine arts, they had, for the very reason of the invincible immobility of their civilisation, been enabled to hand down the industrial arts of antiquity through 5,000 years to modern times. There had been no break in the transmission of the popular knowledge of the technical arts of India. This had been, and would always be, of the utmost advantage to the world, and all the greater because of the still unabridged gulf made in the continuity of Aryan culture by the overthrow of the Roman and Persian Empires; and the further interruption in the tradition of Western art, *i.e.*, the new ecclesiastical art of Christendom, caused by the wanton violence with which the Protestant Reformation was carried out in some of the countries of Europe. The Code of Manu had preserved to the present day in the East the handicraft arts of the lost past in the West. This was the indefeasible service rendered to human culture by the patient, conservative race of Brahmanical Hindus. It was, as viewed from this historical standpoint, that what Mr. Purdon Clarke had told them that night of the domestic architecture of India became so absorbingly interesting. Sir George Birdwood added that, what had always struck him in regard to domestic architecture in India in the buildings he had seen put up, was the sympathetic manner in which the builders seemed to feel their way to what they are doing, and to draw their inspiration from day to day, as their work advanced, from everything around them. In London, for instance, if an architect has to build a house, he does not think at all of the houses next him, but makes his own plans independently of all considerations for his neighbours, and the greater the contrast his house presents to the houses next it, the better he seems pleased. A Hindu architect would never think of acting in that way, but would take care to build his house in harmony with those next it. This was an illustration of the highly cultivated artistic feeling of the Hindus. He never saw them use designs, and their houses seemed to rise under their hands—storey above storey of overhanging richly carved and pillared balconies—and all over painted red for Siva, and for Vishnu yellow, "the colour of joy"—as spontaneously as the spreading hawthorns and laburnums in the summer sunshine of St. James's-park. He hoped that the native gentleman from Lahore who had addressed them would not be misled by the idea that they could learn anything in England for the improvement of the indigenous domestic architecture of the

Panjab. It would be most mischievous if they were influenced by any such idea. The characteristic "cosiness" of English houses, which evidently had charmed them, would be out of place in India, and the sanitary arrangements adapted to England were unsuitable for India. It would be equally erroneous to introduce, as other speakers had proposed, Indian styles of domestic architecture, however fine in themselves, into this country. This would be only to further adulterate English architecture. We have only to go back to ourselves, and be true to ourselves, to build as beautifully as any race in the world; and the true use of the study of Indian or any other foreign architecture, was not to plagiarise from it, but to receive a stimulus from it to do better in our own native way.

A vote of thanks to Mr. Clarke for the paper was unanimously carried.

PREVENTION OF FIRES IN THEATRES.

A public meeting was held on Thursday, May 31st, to consider the report of the Committee appointed to consider the Prevention of Fires in Theatres. Sir WILLIAM SIEMENS, F.R.S., Chairman of Council, in the chair.

The SECRETARY (Mr. H. Trueman Wood) read the Report of the Committee (see p. 687, *Journal*, May 25th).

Mr. SHEAN (of the Fire Brigade Association) said that had it not been for the terrible catastrophe at Vienna, the condition of London theatres would probably be the same now as it was ten years ago; it was the old story of locking the stable door after the horse was stolen. Englishmen were proverbially conservative, but when human life was in danger, one would think the action of those in authority would be sensibly accelerated. The report stated that the matter was inquired into in 1866, and again in 1876–7, and also said that much information was contained in the annual report of Captain Shaw. He should like to know in what annual reports any information with regard to theatres was contained, for he had not seen it. With regard to Mr. Hollingshead's report, he published the report of Captain Shaw, and alongside it a report of Mr. Phipps, the architect, and these two were entirely conflicting, and, therefore, that report was not one on which much reliance could be placed. It was also a fact, which again showed the evils of a conflicting jurisdiction, that the most valuable exit of the Gaiety Theatre was unable to be opened. The next point in the report was that if the condition of theatres was dangerous, the public ought to be informed, but the reason why Captain Shaw's report was not published was, because many theatres were notoriously unsafe. In September, 1881, he (Mr. Shean) addressed a letter to the Lord Chamberlain, in which he said that the arrangements for the prevention of fire at many theatres was notoriously disgraceful, but his Lordship replied that he was not prepared to admit the fact. The Prince of Wales's theatre, before it was closed, had one of the largest audiences in London, and that theatre was simply matchwood. The heat every night was such that, had an accident of the most trifling character occurred, it was no exaggeration to say that the audience would, in every probability, havebeen burnt alive. The appliances for putting out fire were certainly inadequate. The Criterion had also been shut. Since the report of the committee of the House of Commons, five years had elapsed, and a state of things existed which ought not to have existed, yet the Metropolitan Board of Works, in whom had been vested the control of all places of public amusement, did not consider it at all necessary to call for an official report on the character of the places under their charge, until they had been in their hands for fifteen years. The next point he had noticed in the report was this, that supposing any serious accident to occur, a grave responsibility would fall on those who had kept back the knowledge which might have saved valuable lives. But who had kept back that knowledge but the Metropolitan Board of Works, in whose charge these theatres had been for the last fifteen years? Again, with regard to the water supply; he had tested the pressure at almost every theatre in the Strand, and the pressure at the six principal theatres twelve months ago was under 35 lbs. on the square inch. Those who knew anything about fire-brigade work would know that with such a pressure it would be impossible to reach the roof of any theatre in the Strand. Then the committee said they had thought it well to prepare a series of suggestions representing the opinion of those best qualified to judge, but he did not know whom they referred to. The committee went on to say that how these suggestions should be put into actual practice, was a point with which they had not dealt. If that was so, he did not see the use of the opinion of those best qualified to judge. With regard to the inspection made by the Lord Chamberlain, he considered it was a simple farce. The gentleman who made that inspection knew nothing whatever of fire-brigade work or appliances. The manager of the theatre received a letter stating that a gentleman from the Lord Chamberlain's office would call on a certain day at a certain time; the fireman was told to put on his best coat, and receive him and escort him round the house. Whether the appliances were in working order or not, he was not in a position to say, so that that inspection was of no use whatever. The committee said they believed the regulations of the Lord Chamberlain were fairly well attended to. In a letter he had addressed to the *Times*, published the 16th January last, he made statements, which he was prepared to prove, and which were sufficient to show that the Lord Chamberlain's regulations were by no means

well attended to; in many instances they were not attended to at all. It was very true to say that whether they were fairly well attended to or not depended principally upon the good feeling of the managers. That comprised everything, but the good feeling of these managers was a feeling guided by £ s. d., and was it right that the lives of thousands of people should depend upon the will of a manager to go to a few pounds expense or not? Next, the Committee made suggestions in regard to theatres which he supposed were to apply to those to be built in years to come. The rules laid down were very excellent, but what was wanted, as a practical solution of the question of fires in theatres, was not security for those yet unborn, but for the 50,000 or 100,000 people who nightly sought the theatre as a place of rational amusement. Had the Society solved this question? It appeared to him they had not; and, as a practical fire-brigade officer, he would venture to make a few practical remarks. The firemen at all theatres should be enrolled in one body, under proper superintendence. There should be an established fire-drill at every theatre, in which the *employés* should be regularly exercised at uncertain periods. The use of lights on the stage should be guided by strict regulations. Those who knew anything about the lighting of stages knew that many of the iron gas-pipes were joined by india-rubber tubing, and he had been on several London stages when an accident had occurred by the tubing slipping off; the gas escaped, and the first light which came near ignited it. Again the seats should be licensed; unless this were done, who was to say whether a row should take twelve or fifteen? Unless theatres were licensed to hold so many, and the manager was made liable if he took in more than the house was licensed to hold, it was impossible to prevent overcrowding. Theatrical managers had, during the last year, suffered needless worry, and unnecessary annoyance; but what was required for the public safety was first of all a concentration of authority, and the enforcement of regulations adapted to each place of public entertainment. You could not have one set of rules which would apply to every theatre in London. There were large theatres and small theatres, some with large exits and others with narrow ones. To reduce the risk to a minimum all theatres ought to have a certain staff of qualified firemen under proper superintendence, together with adequate means of fire extinction.

Mr. HAWKRIDGE thanked the committee for bringing this subject before the attention of the public, and hoped something would be done in the immediate future. Not long ago a paper was read before the Society, by Mr. McMillan, on the question of fires, when he thought everyone would agree that the most practical part of it was that which dealt with the prevention of fires, and asbestos paint was referred to as being particularly useful. This paint had been used in building the Fisheries Exhibition at South Kensington, in consequence of which the Phœnix Fire-office had taken the insurance at 50 per cent. below the ordinary rate.

Mr. MARRIOTT, of the firm of Astrop and Co., spoke in favour of the use of their liquid cyanite. Although they had only commenced the manufacture in October last, it had been extensively used in London theatres, and also at several theatres in the country.

Mr. ASTROP said the great difficulty with most alkaline silicates was with regard to drying, but he had got over that difficulty by using a basic silicate of alumina. Tungstate of soda was referred to in the report, and it answered very well while it lasted; he had seen it used at the Princess's Theatre over and over again, but they were obliged to repeat it once a fortnight, which made it very expensive on account of the labour; and they had therefore abandoned it in favour of the cyanite.

Mr. HINE (Nottingham) said this was a subject in which he had taken so much interest, that he had come to London a day earlier than he should otherwise have done, in order to attend the meeting. He had noticed in various reports and letters relative to preventing fires in theatres many different schemes, some of which were very good, but he found, generally speaking, they all presupposed the fact that they would inspire such confidence in the audience that they would, with equanimity and self-control, walk out of the place as quietly as if they were coming out of a shop. Now the question of panic was as important as that of fire, and in fact more danger arose from panic, whether the alarm was false or real, than from fire itself. It appeared to him that, so long as the staircase from the various galleries was the only mode of exit, great panics must ensue; but if an intervening space could be allotted, in which the audience could attain comparative safety prior to descending the staircase, this difficulty would be overcome. He would, therefore, suggest that on each side of a theatre there should be a large corridor, wide enough to receive that portion of the audience which happened to be on that side of the house, and as many staircases as there were floors or galleries in the theatre. The communication between these corridors and the theatre should be a series of doors along the whole line of the side walls, level with the floor of the boxes or galleries; the doors should be of iron, or, preferably, of two layers of wood, with cotton silicate between them, hung on spring hinges, so as to open and close of themselves. The audience would thus immediately be able to reach a place of safety, and there would be no difficulty after that in effecting their removal.

Mr. CORNELIUS WALFORD said he was not an expert on this question, but, from various reasons, he

had had occasion to observe many theatres; he had had the advantage of visiting nearly all the theatres in Europe and America, and the real obstacle which this committee and every other had to struggle against was the structural difficulty. It was no use talking about paint and appliances of that sort. Theatres were so constructed that it was impossible for the audience to be safe, in the great majority of instances. It was impossible to stop a fire when a theatre was lighted with gas, or for the people to get out without danger from panic, quite irrespective of fire. The only theatres which he had seen likely to be safe were those of Russia. Those who were familiar with the theatres of St. Petersburg and Moscow would know that they were built in large open spaces, constructed in some cases very much like the Royal Albert Hall, with an outer shell and an inner shell; when a fire took place in the inner shell, the people had no difficulty in removing rapidly to the outer shell, or the passage between the two, and in that way they were safe. So long as theatres were built in holes and corners, with innumerable passage-ways, there would be extreme peril, so that every time he went to the theatre he looked to see what were the means of getting out. He had no interest in any appliance, but he had read a specification which had been sent to him, which seemed to be very ingenious. In the event of a fire breaking out through an escape of gas, there was a power of turning on water through the gas-pipes; the water would escape to the place where it was wanted, and the gas, of course, in that section was put out. The effect of putting the gas out suddenly all over the theatre might be very dangerous, but this mode of applying water rapidly, in part, seemed to him the thing which aimed in the right direction. In Paris he had noticed the extreme agility with which firemen came to the rescue, and he once sat in the *Chatelet*, and saw the boxes on the other side burn out. He saw the fireman had command over the fire from the moment it occurred, and put such a supply of water on it, as almost to wash the boxes out, and so put out the fire. The theatre was badly constructed, as nearly all theatres were. Where the boxes were crowded together, made of wood, and covered with paper, they were made to burn. If it once caught fire, down would go the theatre, and if it did not, everybody, fearing it, would scramble to get out. He saw no solution of the difficulty but by their gradually burning or pulling down the existing theatres, and building new ones in such places, and under such conditions, as would provide for the safety of the public.

Mr. JOHN HEBB (assistant architect and surveyor to the Metropolitan Board) said Mr. Hine struck the right note when he said the great difficulty was the prevention of panic. No structural excellence could compensate for the want of presence of mind amongst the audience. He was surprised that the Society of Arts should take the trouble to draw up a report of such a character as this, which was not at all calculated to allay the fears of an audience, but, on the contrary, was rather calculated to create alarm. The dreadful circumstances which attended the fire at Vienna had scarcely passed from men's minds, but the apprehensions excited by that calamity were now beginning to pass away, and he thought the Society was not doing any good work, but a very mischievous one, in calling attention to defects in theatres, which were at present incapable of removal. The report was of a very elaborate character, but he did not find one suggestion which was novel or practical. It all dealt with platitudes. They were told it was necessary the theatre should have a good approach, and roomy corridors, and good staircases; and suggestions were made that, perhaps, it would be a good thing to have a fireproof curtain, but there were disadvantages in that; there were also disadvantages in having a secondary system of lighting. In fact, there were disadvantages attending pretty nearly all the recommendations which were made. It appeared to be a very inconclusive kind of report, and as far as he could see, would not answer any practical purpose. When the committee came to consider questions on which the public would desire to be informed, they said simply, "This is a thing which we do not consider comes within our purview;" or "we have preferred to keep to one special part of the subject." Again, with regard to regulations for the safety of theatres, they were not prepared to make any recommendation. In fact, on all those points on which it might have usefully given information, the committee was perfectly dumb. Nor was the report more useful when it treated of the matter historically. He found, for example, the title of the Act of Parliament under which some very important works had been carried out by the Metropolitan Board of Works was misstated. The powers possessed by the Board were attributed to the Building Act, which dated from 1855; whereas they were conferred by an Act passed only in 1878, and which was an amendment of the Metropolis Local Management and Building Act. Nor did the Society give any information with regard to the extremely useful work done of late years by the Metropolitan Board of Works. They did not say that a large number of theatres had been surveyed, that very important works had been carried out, that in one case an expenditure of about £15,000 was incurred in the acquisition of ground, and the carrying out of works; that in another case, something like £4,500 was spent on a single theatre, and that in other theatres sums varying from £1,000 to £2,000 had been spent for the purpose of improving the means of ingress and egress, and securing the safety of the public. All this the Society did not know; nor that the Metropolitan Board had acquired a large amount of information with regard to theatres abroad, had translated all the regulations made by different foreign municipalities, and drawn up a code of regulations which governed the erection of new

theatres. Those regulations were of a very minute character, and went to the construction of every part of a new theatre. With regard to old theatres, the Board did not insist that they should be brought strictly in harmony with those regulations, but had endeavoured, as far as it was practicable, and with as little interference as possible with the comfort of the audience and the convenience of managers, to carry out the Act of Parliament giving them power over these buildings. The meeting, perhaps, was not aware of the very limited control which the Metropolitan Board had over theatres. Mr. Shean, to his astonishment, informed the meeting that the Board had had control of the theatres since 1866, but this was quite new to him. The Board had had no such control; it had only had control since 1878, and the Act of 1878 only gave the Board power to require the owners of new theatres to make structural alterations in case the safety of the public was imperilled. The exercise of this power is restrained by the necessity of obtaining the consent of the Lord Chamberlain in the case of theatres, and of the Home Secretary in the case of music-halls, and structural alterations could only be such as could be carried out at a reasonable cost. If Mr. Shean fancied riding about in a large van and stopping at theatres during the time a performance was proceeding, was calculated to inspire confidence either in the public or in the managers, he could only say he was of a different opinion. If the Society desired to do anything to secure or improve the safety of the public in theatres, the committee should devote themselves much more seriously to the work, and a report should be prepared of a more exhaustive character, and the suggestions made should be of a practical nature.

Mr. Dixon-Hartland, M.P., said he considered the subject so important that, for the last three years, he had been pressing it on the House of Commons in every possible way. He could not at all agree with the gentleman who last spoke, and he thought the Society was doing very valuable work in calling attention to the present state of London theatres, and he had no hesitation in saying that, at the present time, almost every one of those was in a state far from satisfactory. Mr. Hebb seemed to be speaking in defence of the Metropolitan Board of Works; but the Act of 1878, to which he alluded, was in existence for two years before the Metropolitan Board acted upon it in any shape whatever; in fact, they never took the slightest notice of it until he brought the matter before the House of Commons, and he did not believe, if he had not done so, they would have taken any notice of it at all. When he asked the Home Secretary if their powers were sufficient, he said they were, and the Chairman of the Board, Sir J. McGarel Hogg, said the same. If they were not sufficient, they should ask for further powers. But what was the result? Take the case of the Alhambra Theatre; he examined that most carefully immediately after the fire. Under a part of the stage there was a soda-water manufactory in full work, and gas retorts for making gas for the theatre. Over another part of the theatre there was a lodging-house, where over 300 men were allowed to smoke in bed, only separated from the theatre by a thin wooden partition. Under the dress-circle was a great quantity of old properties stored, and the floor had open spaces where matches could drop down, which was really the cause of the fire. When he asked Sir J. McGarel Hogg the reason that was allowed to continue, he said they knew all about it; they were talking about it at the time the fire took place. That was four years after the Act passed, and how did they know when another fire took place, in another four years' time, that they would not be told the same. Mr. Walford was quite right when he said it was impossible to prevent fires in theatres. The average length of the life of a theatre was under 23 years. Do what you might, from the inflammability of the scenes, and the various gas-lights flaring about, it was impossible to prevent fires. He thought the proper way was to have the exits in such a shape that the public should be able to know that they could get out. The real danger was panic, and the only way to prevent panic was for the public to know that in case of fire they could escape without any difficulty. Every part should have a separate exit; no two parts should converge together so as to cause a block, and all the doors should open outwards. There should be no doors with a notice on "Exit in case of fire," because they all knew that when the public went to a theatre they went in at one way, and they got so accustomed to it they all rushed to it. All these doors should be open every night, so that the public might get accustomed to them, and would know they were in working order. The present system was radically wrong. He could remember when the stalls were 4s. 6d., and now they were 10s. 6d., and the public had a right not to go at the risk of their lives. This was a public question, not a question of profit and loss. Supposing a fire occurred in any London theatre that night, there would be 300 or 400 people burnt, then what would the public say—that there had been great want of common sense. They ought to insist on safety as the first thing, even if they had to pay a little more for it, so that they might know when they were going to a theatre they were not going to risk their lives. The Society had done good work in bringing the question forward, and he hoped they would continue it until some satisfactory conclusion was arrived at. He had much pleasure in moving the first resolution, viz.:—"That the present official system for the regulation of theatres is unsatisfactory, and does not adequately provide for the protection of the public from the risk of fire."

Mr. Liggins, in seconding the resolution, said he was old enough to recollect two terrible fires—one of which he saw—which happened to two of the largest

theatres, Covent Garden and Her Majesty's. Covent Garden he saw blazing away, and Her Majesty's theatre he saw the day after it was burnt down. On both occasions he believed the cause of those theatres coming to the ground was that the tank at the top was empty. He knew there was a tank larger than the whole of that hall on the roof of Her Majesty's theatre, and if it had been filled with water, it must have prevented the destruction of the house, but it was well-known at the time that the tank was empty. That brought him to the point which should be urged with great force, that there ought to be a real, true, honest inspection of theatres; that all theatres should have large tanks to make up for the deficiency of pressure in the water mains. He did not think it was possible to keep the water mains always at a pressure which would give a command of water to the top of the buildings. With regard to the structural arrangements, in these days it was a disgrace that there should be any inflammable material whatever in a theatre. The walls ought to be of the best brickwork, the girders of iron, the floors with nothing but iron and cement in them, and the fronts of the boxes ought to be of cement also. There were now no more inflammable parts than the ceilings, but they might be made as cheap by making them in skeleton light ironwork, which could receive a surface of Keene's cement, which would readily take any decoration put upon it. Drill ought to be frequent, and at varied times, so that no one should be prepared with a smart helmet and uniform on, but should be ready at any moment to put out a fire. He might mention a circumstance which occurred to him some years ago, on a large ocean steamer, soon after the fire on board the *Amazon*, when the attention of all England was drawn to the safety of ships at sea. The steamer in which he then was had been specially fitted with extra pumps, with a view to facilitate the checking of any fire, and had been thoroughly surveyed. In a terrible gale which took place in the Channel, the ship gave a fearful lurch, which caused a man to fall and strike against the wires that rang the fire-bell. They were all alarmed, and everybody rushed to their stations; the drill on board that ship was very perfect, and the pumps were put to work immediately, but not a single drop of water would they draw. The reason was that the pumps had been placed after the ship was launched, and passed by the Board of Trade, but the supply pipes under the paddle wheels were not sufficiently low in the water when the ship rolled to allow of their drawing anything but air, and it was found necessary to dock the ship at Southampton for the express purpose of lowering these pipes. That showed that inspection should be intelligent. To give another illustration; he remembered last Christmas-time going to the promenade concerts at Covent-garden, where he noticed there were large hydrants, and excellent hose all round the pit fitted some few feet above the ground at the outside of the circle. Now, what would be the result if a fire took place in the pit; there would be a rush out of the pit to get into the street, and it would be utterly impossible to manipulate the hose placed there. They would have to be placed across the passage way where the people would fall over them, trample on them, and very likely destroy them, and they would be covered with a mass of human beings. It would have been much more easy to raise the standpipes to the ceiling, take it up through the ceiling, and lead the nozzle out just at the back of the dress circle, whence it could have been easily manipulated to throw any amount of water required into the pit. It was astonishing that the Board of Works, to whom they looked for protection under the Act of Parliament, did not insist on more sensible arrangements. He strongly supported the resolution, because he believed the Society would be doing good and useful work to the public, and would aid the authorities in carrying out their necessary duties.

Mr. HERMAN (business-manager to the Princess's Theatre) said he did not speak against the report, because he could say, without fear of contradiction, that there was not one single recommendation in it which had not been adopted by the management which he represented; but he must protest against the general charges in the speech of the mover of the resolution against theatrical managers. The previous speaker had made a very significant remark, viz., that intelligence should be brought to bear on the prevention of fires; but the same gentleman said that in setting the pumps of a large Atlantic steamer to work, they were found out of order; he might, with just as much justice, bring a charge against all ship-owners. Whatever might be proposed, you could not prevent a theatre being burnt; from the nature of the construction, and the business carried on there, they were almost certain to be burnt at some time, it might be 20 years, 40 years, or 100 years, but the theatre would come down. What must be guarded against was panic, and these very sweeping assertions and charges made against all managers, not merely against those who were really guilty, unsettled the public mind, and stimulated the very panic which they wished to prevent. Every one of the arrangements proposed was adopted by most of the responsible managements in London, particularly in those over which Mr. Barrett had control. First of all, structural arrangements were undoubtedly necessary. Every door should open outwards, and every passage should be free, because when you got a mass of people converging on another mass at a certain point, ruin and destruction must ensue. At the Princess's there was a separate exit from every part, and so there was in all other well-arranged theatres. Some managers were not liberal enough to keep all the doors open every night, and to station men to keep them open, but Mr. Barrett did so. It was a matter of 15s. a week for each door, but the public had a right to expect that they should pay that. Every door in the Princess's was not only

open every night, but protected by a man—an old policeman especially chosen from the A Division, well accustomed to deal with large crowds, and they were specially selected for their size and weight, because where a small man would be carried away, and trampled on, a man of 6 ft. 4 in. would not. They were the first to introduce the lighting of theatres with oil lamps as well as gas. He had been laughed at, but no matter whether a theatre were lighted by electricity or gas, it should be supplemented by an agent which could not fail by the connection of wires and pipes. The next point was the arrangement and treatment of scenery and accessories with some non-inflammable substance. They used cyanite to prevent fire, and since then it had been largely used elsewhere. With regard to the illuminating appliances for the stage, in all good London theatres the lighting was effected by two or three different meters, and the lime-lights were supplied by tanks outside. There were very few pyrotechnic matters used except in pantomimes, and then in very small proportion. Wirh regard to the regulations, Mr. Barrett employs four trained firemen, and every single man employed in the theatre was drilled every fortnight by the district engineer of the Metropolitan Fire Brigade. Every man knew his business as well as a fireman, and about a year ago the Princess's staff put out a fire in adjoining premises before the Brigade people came up. One other thing he might remark about the separation of the auditorium from the stage. That had been a matter of great consideration with him, and Messrs. Merryweather could tell them that about two years ago he suggested a curtain constructed of asbestos cloth, saturated with water, and it was only a matter to be decided how the water to be supplied to it could be carried off. No doubt a curtain could be devised which should, in cases, separate the audience from the stage, but the curtain should be as light as air, and still as resistant to fire as water itself. That could only be constructed out of fire-proof light material, saturated with water, and he was now making some designs for the purpose of constructing this in such a way that, in saturating it with water, the stage itself and the adjoining portions should not be more damaged than necessary in the experiments. Having made these general remarks, he might say that the efforts of the Society should certainly be directed towards the prevention of fire, but more towards the prevention of panic, and for this purpose it should not state generally that theatres were unsafe, thereby engendering panic. When an outcry was raised in a theatre, whether it was water, fire, or beer, the people began to run. Some time ago, in Leeds, the bung of a beer-barrel flew out, and an idiotic woman, who was half drunk, cried out "beer." It was taken for a cry of "fire," and a stampede would have occurred had it not been stopped by the tact of the officials. He did not think it at all wise to try and foster a panic which would lead people to think they ought to rush away at any cry anyone thought proper to raise.

The CHAIRMAN said everyone must have listened with great interest and pleasure to the remarks of Mr. Herman, a practical stage-manager of one of our large theatres, and with the view of meeting the objection which he raised against the resolution, he would suggest a slight modification of it, which probably would leave it as efficacious, without casting any slur against those who were now giving their careful attention to the prevention of fires which he did. He would suggest the insertion of the word "certain" before "theatres."

Mr. DIXON-HARTLAND said Mr. Herman's remarks were most valuable. He might be allowed to say that the management of the Princess's did their best, and it would be a good thing if every manager would come forward to prove that he did his best, and then the public would learn for themselves which theatres were safe and which unsafe, so that those who really did their duty would have the advantage of it. It was within his knowledge that in Captain Shaw's report he recommended that a certain number of theatres should not have their licenses renewed until certain structural alterations had been made, but in every case but four they had been renewed, although the structural alterations had not been made. He should be quite willing to substitute the word "inspection" for "regulation."

Mr. SHEAN said the fire brigade throughout London were quite aware that the Princess's Theatre was very safe indeed, in fact the safest, but any gentleman could go on a Saturday evening to another place of entertainment which he would not name, and he would prove to him that, in case of fire, the people stood every chance of being burnt alive; therefore, although they might acknowledge that the Princess's was absolutely safe, so far as human means could be devised, still there were other places which were not safe, and to those the resolution referred.

The resolution was then put in the following form:—"That the present official system for inspection of theatres is unsatisfactory, and does not adequately provide for the protection of the public from the risk of fire." In this form it was carried unanimously.

Sir FREDERICK ABEL, F.R.S., as a member of the committee which had put forward what was no doubt called a report, but what was, really, more a collection of information, expressed his gratification at the useful effect it already had. It had been objected that it did not deal with the subjects practically; but he would simply say, in reply, that the members composing the committee could not do so with the data before them, owing to the difficulty of getting authoritative information on many subjects from public and private bodies. They could only

draw up memoranda calculated to elicit such information as they had been gratified by receiving that evening from an official of the Metropolitan Board of Works, and from gentlemen of experience like Mr. Herman. The importance of dealing with panics had been so much dwelt upon, that he need not say anything upon it, but the committee could hardly be accused of increasing the tendency to panic by collecting such facts as they were able to put forward. At any rate, they had had the satisfaction of feeling that some kind of confidence might be restored by listening to men like Mr. Herman, who showed, among the managers of theatres, they had men possessed of that intelligence which it had been pointed out was so important, and of an intense desire to carry out to the uttermost the important duties devolving upon them. The resolution he was about to propose would be useful if it had the desired effect of directing attention to means which for many years had been more or less satisfactorily developed; means not for rendering materials uninflammable, for that was impossible in the case of materials which were intrinsically combustible, but for diminishing the inflammability of materials used in structures, such as theatres, or for decorative purposes. It had been his duty, in an official capacity, for the last 30 years, from time to time, to give attention to the materials proposed for effecting such purposes, and he could say, with confidence, that materials did exist, the proper application of which was not attended with any great amount of danger and inconvenience, and which, although they were not susceptible of universal application, in connection with structural materials which are exposed to view, were extensively applicable, and with very beneficial results. There was no doubt of the benefits to be derived from the application of alkaline silicates which was worked out about thirty-five years ago by an eminent German chemist, Professor Fuchs, and which were used on a large scale in connection with structural materials in Austria, nearly as long ago as that. They could either be applied alone, or in conjunction with various mineral matters, such as white lead, or, still better, oxide of iron pigments, or asbestos in a finely-ground condition. These materials might be applied for the purpose of providing on the surface of wood a coating, which when exposed to heat, become fused or partially fused, and thus formed a kind of vitreous coating on the wood, protecting it more or less from the action of flame. As pointed out in the report, wood thus treated, when subjected to the action of heat, did, like coal in a retort, undergo destructive distillation and yield gas, but the charred fibre itself did not burn, because oxygen was excluded from it. That was the chemistry of the matter; hence it was that combustibility was not prevented, but was greatly retarded when materials of this character were applied to wooden surfaces. Again, canvas materials or fabrics might be not only coated but impregnated with such substances as the silicates, which rendered them almost uninflammable. In many cases, the strength of the fibre was more or less deteriorated by such application, but in the case of scene painting this would be of minor importance, and could be guarded against. He believed that the application of silicates and other materials in conjunction with them to canvas, and to other fabrics used in decorative purposes, would diminish the tendency of fire to spread when it broke out, and it was only to this extent that these materials could be useful. It would be wrong to expect too much of them, or to imagine that, by coating with asbestos paint, cyanite paint, or silicate of soda and lime, the substance was rendered uninflammable. All that could be done was to prevent the spreading of flames when once fire had broken out, but that was a most important thing, for very often a few minutes were of the most vital importance, not only as regards the safety of buildings, but of those in the building, and it would have a most important effect in diminishing the tendency to panic if it were generally known that managers made what use they could of such materials. He admitted there were difficulties, but managers had only to point out these difficulties, and chemists would overcome them. He begged to move:—"That it is important that attention should be given by managers of theatres to the known methods for reducing the inflammability of structural or decorative materials, and that it is desirable that more use should be made of such methods."

Mr. SHEAN seconded the resolution.

Mr. HEBB asked if Sir Frederick Abel was aware that tungstate of soda had been used in Paris for the purpose of preventing textile fabrics, and had been discarded as being impracticable in use. He had heard that it was very much objected to by the actresses as destroying the appearance of their dresses, and the difficulties with regard to the scenery were also so great that eventually its use was discarded.

Mr. HERMAN said he used it for some time, and the only difficulty was that it evaporated, and had to be used about once a fortnight. They were now using Mr. Astrop's cyanite, and found it thoroughly satisfactory. It did not destroy any fabric, and no scenery or canvas painted with it would burn.

Sir FREDERICK ABEL said he did not think it was necessary to enter into details, and he had not particularised many substances, fearing that he might be entering into a discussion which, though it might be interesting to many, might be tedious to others. He knew there had been difficulty in the application of tungstate of soda, and that it had not been persevered with in Paris on that account, but it did not follow that the difficulties might not be overcome. It was quite new to him to hear that tungstate of soda evaporated, and he should almost imagine that, under that name, one of the many other anti-combustible preparations must have been supplied which would have that property.

The resolution was carried unanimously.

Lord ALFRED CHURCHILL moved the next resolution :—"That in all cases where serious loss of property has occurred through fire, provision ought to be made for holding an official inquiry by some competent authority." He said, a month or two ago, an excellent paper on this subject was read by Mr. Walford, in which he commented on the necessity for official inquiry into causes of fire. Wherever a fire might take place, it seemed important that there should be an inquiry, irrespective of loss of life. If life were lost an inquest was held; but there were numbers of fires where no loss of life occurred, but still it seemed necessary that some public inquiry should be made. Of course, the question might be raised, "Where do you draw the line? Fires were small when they began, and only did damage when they extended." It might be difficult to determine that, but whenever a fire took place in a theatre, or in a large public place, an inquiry should be held. A fire took place a short time ago at the Freemasons'-hall, which, fortunately, was not attended with any great danger, but had it occurred at a time when that large room was filled with people, very serious loss of life might have occurred through the panic which might have ensued. The principle was admitted in the case of ships and railway accidents. However small the accident in the latter case, the Board of Trade sent down a commissioner to enquire into the cause, and he reported whether there had been any neglect on the part of the authorities. A similar inquiry was made in the case of shipwrecks, although no loss of life occurred, and the natural result was to produce greater care. The Council of the Society had agreed to draw up a memorial to the Government on this subject, but they wished to be supported by the opinion of the meeting, especially as he understood that such a thing could not be carried out without an Act of Parliament.

Mr. CORNELIUS WALFORD seconded the motion. He had considered this question of fire inquests for many years, and had discussed it before other societies, and the general concensus of opinion was that such inquiries should take place. The primary object was to bring home to any person who, by carelessness or neglect in any form, had jeopardised the lives of a great number of persons. The certainty of an inquiry taking place, and the chance of bringing home such a crime to any person would inevitably lead to more care being taken, and in consequence the public would get a protection which they would not by any other means.

Mr. LIGGINS said very possibly a short clause might be introduced into one of the Bills which the Metropolitan Board frequently brought before Parliament.

A MEMBER asked if there were a tank at the top of the Princess's Theatre?

Mr. HERMAN said there were five, and besides that they had a direct supply from the main, and they constantly watched to see that the tanks were filled with water. These tanks not only protected the theatre, but the whole district, for they were available when the water company's mains were without water.

Mr. DENNIS did not see why the inquiry should be confined to cases where serious loss to property occurred. In many cases where even a small loss of property occurred, lives might be lost.

Mr. WALFORD said they would want a thousand coroners if inquiries took place in every case.

The CHAIRMAN said it would be difficult to distinguish accurately the cases in which inquests should be called for. There might be a fire of the slightest possible character, where a dress was slightly singed, which would not come to public notice. It must necessarily be left to the authorities to decide on what cases are called for inquests.

The resolution was put and carried unanimously.

Mr. HERMAN proposed a vote of thanks to the Chairman, which was carried unaninously.

The following are the three resolutions passed at the meeting :—

I.—"That the present official system for the inspection of theatres is unsatisfactory, and does not adequately provide for the protection of the public from the risk of fire."

II.—"That it is important that attention should be given by managers of theatres to the known methods for reducing the inflammability of structural and decorative materials, and that it is desirable that more use should be made of such methods."

III.—"That in all cases where serious loss of property has occurred through fire, provision ought to be made for holding an official inquiry by some competent authority."

Miscellaneous.

GREENWICH OBSERVATORY.

The annual visitation of the Royal Observatory was held on Saturday, the 2nd inst., when the report of the Astronomer-Royal (Mr. W. H. M. Christie, F.R.S.) was presented to the Board of Visitors. The report refers to the work of the Observatory for the year ending May 20th, 1883.

The instruments purchased for the transit of Venus, 1874, after being used for the observation of the transit of Venus, 1882, have for the most part

been returned to the Observatory. The "Naylor" equatoreal, an altazimuth, and a clock (Dent 2015) were lost in the wreck of the *City of Brussels* on the voyage back from Bermuda.

Astronomical Observations.—The regular subjects of observation are the sun, moon, planets, and fundamental stars, with other stars from a selected list. The working catalogue of 2,500 stars down to the fifth magnitude having been cleared off, a new working list of 2,600 stars, comprising all stars down to the sixth magnitude inclusive which had not been observed since 1860, has been prepared, and was brought into use at the beginning of March. About 1,200 stars were observed in 1882, but amongst these there are nearly 500 single observations, necessitating careful comparison with catalogue place for the detection of any mistakes of observation or reduction.

A very valuable addition has been made to the instruments of the Royal Observatory by the gift of the Lassell two-feet reflecting equatoreal, which has been generously presented by the Misses Lassell. The exceptional qualities of this fine telescope (with which Hyperion was discovered in 1848) are well known, and there could be no hesitation in accepting, on the part of the Admiralty, the offer of such a valuable gift. The instrument was removed from Maidenhead early in March, and has been erected in the south ground, where it commands a nearly unobstructed view of the sky to within 5° of the horizon. A circular building 30 feet in diameter has been erected for the Lassell telescope, and the construction of a suitable dome is authorised. There are two large mirrors available for use, and I contemplate taking advantage of the firm mounting and perfect clock movement of the south-east equatoreal to mount the spare mirror on this instrument, attaching it to the tube of the refractor, so as to have on the same mounting a refractor and reflector, with their axes parallel. The former would be available for eye observation, whilst the latter could be used on the same object for physical work, spectroscopic or photographic. The Lassell telescope itself would be well suited for observation of faint satellites and comets which are at present beyond our instrumental means.

The south-east and Sheepshanks equatoreals are in good working order. The loss of the Naylor equatoreal by shipwreck has already been mentioned. One of the Simms' six-inch equatoreals, recently repaired after use in the late transit of Venus, is being mounted in the south ground for occasional use.

With one or more of these equatoreals, or with the altazimuth, 11 occultations of stars by the moon (seven disappearances and four reappearances) and 37 phenomena of Jupiter's satellites have been observed in the twelve months ending 1883, May 20th, and the observations of occultations have been reduced to the end of 1882. The great comet *b* 1882 was observed on ten nights, and comet *a* 1883 (Brooks-Swift) was observed on four nights with the Sheepshanks equatoreal. Comet *c* 1822 (Barnard) was observed on one night with the south-east equatoreal. Micrometer observations of six of Saturn's satellites were made with the south-east equatoreal on nine nights, and with the Sheepshanks equatoreal on six nights, but in these last it appears that Titan was the only satellite observed. Four measures of Titania, the third satellite of Uranus, were also obtained on one night.

Preparations were made for observing the transit of Venus on December 6th, but clouds completely hid the sun from view during the time of the transit.

The observations of the solar eclipse of 1882, May 17, with the south-east equatoreal are completely reduced, and the final equations have been solved.

Spectroscopic and Photographic Observations.—The spectroscopic observations during the past twelve months have been somewhat restricted through the pressure of the photographic reductions at a time of maximum of sun-spot frequency. The solar prominences have been observed with the half-prism spectroscope on eight days, and four sun-spots have been examined on eight days with reference to the broadening of lines in their spectre. The spectrum of the great spot of 1882, November 12—25, showed some remarkable reversals of the lines of hydrogen and sodium, and an extraordinary displacement of the F line.

As regards the determination of motion of stars in the line of sight, 142 measures have been made of the displacement of the F line in the spectra of 23 stars, and 26 measures of the b_1 line in 9 stars. The observation of Sirius during the past winter tend, on the whole, to confirm the impression that the rate of recession of this star has diminished progressively since 1877, and that the motion is now on the point of being converted into one of approach.

The spectrum of comet *a* 1882 was examined on three nights, that of the great comet *b* 1882 on three nights, and that of comet *a* 1883 on one night. The spectrum of the first-named object showed the yellow sodium lines with great brilliancy just before perihelion passage. The spectrum of the aurora of 1882, November 17, was also examined.

The spectroscopic observations of all kinds have been completely reduced to 1883, May 20th.

In the year 1883, May 20th, photographs of the sun have been taken on 200 days, and of these 339 have been selected for preservation. There were seven days on which the sun's disk was observed to be free from spots. The number and size of spots and faculæ continued to increase in a marked way till last November, when a group of spots of very unusual size appeared. Since that date, however, the sun has become more quiescent.

Since the beginning of December gelatine dry-plates have been used instead of the old wet-plate process. They are more convenient in use, and appear to give as good average results. The photographs on a scale of eight inches to the sun's

diameter recently obtained in India, under the auspices of the Solar Physics Committeee, are so successful that the committee have recommended the general adoption of this scale, and I propose, as soon as we have a spare photoheliograph returned from the Eclipse Expedition, to have it altered in the same manner as the Indian photoheliograph, so as to obtain eight-inch photographs of the sun instead of four-inch.

It was suggested in the last report that the measurement of such of the Indian and other photographs as were required to fill up gaps in the Greenwich series, might with advantage be undertaken here. This proposal has now been carried out, and 111 photographs for the period from 1881, December 22, to 1882, October 19, have been received from the Solar Physics Committee, so that a record of the condition of the sun on 279 out of the 302 days in that interval is now presented. From 1882, October 20, eight-inch photographs were taken in India, and for the measurement of these a special micrometer has been ordered of Messrs. Troughton and Simms by the Solar Physics Committee.

Magnetical Observations.—The course of observation continues the same as in former years, changes in the magnetic declination, horizontal force, and vertical force being continuously recorded by photography with the three magnetometers, whilst absolute values of magnetic declination, dip, and horizontal force are found by eye observation. Earth-currents in two directions, nearly at right angles to each other, are also photographically registered.

A great improvement has been made in the photographic registration by the substitution, in June last, of Morgan and Kidd's argentic-gelatino-bromide paper with ferrous oxalate development, for the old photographic process. The greatly increased sensitiveness of the new photographic paper allows of a great reduction in the effective surface of the concave mirrors carried by the magnets, and in the size of the gas flames. Much greater sharpness in the photographic trace is thus secured, and there is no trouble from discolouration. The saving in gas and in computers' time in preparing and developing the sheets probably makes up for the increased cost of the paper, which is rather expensive.

There has been considerable magnetic activity during the year, the month of November, which was characterised by the appearance of a very large sun spot, being particularly disturbed with remarkable magnetic storms, on November 17, 19, and 20, and many interesting cases of lesser disturbance. The magnetical changes in November are so interesting in relation to the accompanying outburst of sun-spots, that it seems desirable to have the registers for a great part of the month, as well as for other days of magnetic disturbance in the year lithographed in the 'Greenwich Magnetical Results for 1882,' on a reduced scale.

Meteorological Observations.—The following is the state of the meteorological reductions:—The observations of barometer, thermometers, anemometers, rain-guages, and sunshine instrument (corrected, where necessary, for instrumental error) are reduced up to the present time. On the photographic sheets time-scales are laid down for the barometer and dry and wet bulb thermometers to the end of 1882, and for the electrometer to June 30. The hourly ordinates for the barometer and dry bulb thermometer are read out to the end of 1882; for the wet bulb thermometer, to June 30; and for the clectrometer to 1882, January 31. The hourly and monthly means in 1882 have been commenced for the barometer.

The mean temperature of the year 1882 was 49°·6, being 0°·1 lower than the average. The highest air temperature was 81°·0 on August 6, and the lowest 22°·2 on December 11. The mean monthly temperature was above the average from January to May, then below until September. In October, November, and December it differed little from the average.

The mean daily motion of the air, in 1882, was 306 miles, being 27 miles greater than the average. For the month of November, the mean daily motion was 449 miles, being 159 miles above the average. The greatest daily motion was 758 miles on Nov. 4, and the least, 30 miles on December 11. As already mentioned, the greatest hourly velocity was 64 miles an hour, and the greatest pressure (with the chain) 29 lbs., on October 24.

The number of hours of bright sunshine recorded by Campbell's sunshine instrument during 1882 was 1,245, which is more than 40 hours above the average of the five preceding years.

The rainfall in 1882 was 25·2 inches, being very slightly above the average.

Chronometers and Time Signals.—The number of chronometers now being tested at the Observatory is 154. Of these 114 (seventy-seven box-chronometers, sixteen pocket-chronometers, and twenty-one deck watches) are the property of the Government, and are being rated after repair previous to their issue to the Navy. The remaining forty are placed here for the annual competitive trial, and of these eight are fitted with Airy's supplementary compensation. In addition to the above, five chronometers have been tested here for the new Hong Kong Observatory.

The first six chronometers in 1882, as tested by their trial numbers, are on the average better than the first six in any year since 1873, and the first chronometer performed better than any we have had previously on trial. The trial in cold was, however, not quite so severe in 1882 as in preceding years.

There has been no case of failure in the automatic drop of the Greenwich time-ball. On three days the ball was not raised on account of the violence of the wind.

The Deal time-ball has been dropped automatically at 1^h on every day throughout the year, with the exception of five days, on which there was failure in the telegraphic connection, of one day when the ball was accidently dropped 4^s too soon by telegraph

signals, and of fourteen days when the current was weak, and the trigger was released by the attendant without appreciable loss of accuracy. On twelve days the ball was not raised on account of the violence of the wind.

The Westminster clock has maintained its high character, its errors having been under 1s on 66 per cent. of the days of observation, between 1s and 2s on 25 per cent., between 2s and 3s on 6 per cent., and between 3s and 4s on 3 per cent. The error has never exceeded 4s."

General Notes.

LOUISVILLE EXHIBITION.—Copies of the circulars containing information respecting the Exhibition, and of the Annual Report of the Louisville Board of Trade, have been sent to the Society of Arts by the Science and Art Department, and copies can be obtained on application to the Secretary.

FISHERY CONGRESS.—A series of conferences will be held in connection with the International Fisheries Exhibition, on Mondays, Tuesdays, Thursdays, and Fridays. The first meeting will be held on Monday, 18th June, at 12, noon, when Professor Huxley will deliver an introductory address. H.R.H. the Prince of Wales, K.G., has graciously consented to read a paper by H.R.H. the Duke of Edinburgh, K.G., entitled—"Notes on the Sea Fisheries and Fishing Population of the United Kingdom," on Tuesday, 19th June, at 12 o'clock.

MADRID MINING EXHIBITION. — The Madrid Exhibition of Mining and Metallurgy was opened on the 30th May. From an early hour several thousand persons flocked to the Retiro Park, where the châlets and buildings of the Exhibition are scattered round the large main edifice. There the opening ceremony took place, in the presence of 500 distinguised guests and the King of Portugal and Don Alfonso. The latter made a speech, urging the necessity of carrying out public works and developing the natural mineral wealth of the Peninsula. The British section is well represented. Sweden and Germany, and also Spain are strong in ores of all kinds, glass, and pottery.

CALCUTTA EXHIBITION.—A new scheme for the discovery of fibres has just been proposed by the Revenue and Agricultural Department of the Government of India, in connection with the International Exhibition to be opened at Calcutta next December. It is intended to allow experimental trials in the extraction of fibres of all kinds to be made at Calcutta during the ensuing rains, and the Government has decided to do all in its power to render the experiments as successful as possible. With this object in view, it will provide stems and other fibrous portions of fibre-bearing plants or trees, and, as far as possible, motive power. Those who desire to perform experimental trials are expected to register their names at the office of the Revenue and Agricultural Department before the end of June. The plants suggested for trial are to be found in India.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 11...Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. The Earl of Mayo, "A Journey from Mossamedes to the River Cunené, South-West Africa."

British Architects, 9, Conduit-street, W., 8 p.m. 1. Presentation of Medals and Prizes. 2. Mr. R. T. Chisholm, "College at Baroda."

TUESDAY, JUNE 12...Gas Institute, Firth College, Sheffield, 10 a.m. Annual Meeting. 1. Inaugural Address by the President. 2. Reading of Papers and Discussions.

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Photographic, 5a, Pall-mall East, S.W., 8 p.m.

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. 1. Dr. Edward B. Tylor, "Old Scandinavian Civilisation among the Modern Esquimaux." 2. Mr. A. W. Howitt, "Some Australian Beliefs."

Royal Colonial, the Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Mr. D. Morris, "Planting Enterprises in the West Indies."

WEDNESDAY, JUNE 13...Gas Institute, Firth College, Sheffield, 10 a.m. Annual Meeting. Reading of Papers and Discussions continued.

Microscopical, King's College, W.C., 8 p.m. 1. Prof. F. Jeffrey Bell, "Note on the Spicules of *Cucumaria Calcigera Chyndmanni*, and of Two Allied Forms." 2. Mr. Conrad Beck, "Some New *Cladoceræ* of the English Lakes." 3. Herr J. Flagel, "Cutting Sections of Diatoms."

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

THURSDAY, JUNE 14...Gas Institute, Firth College, Sheffield, 10 a.m. Annual Meeting. Reading of Papers and Discussions continued.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Professor H. Lamb, "The Mutual Potential of Two Lines in Space." 2. Mr. R. Tucker, "Inverse Co-ordinate Curves."

FRIDAY, JUNE 15...Royal United Service Institute, Whitehall-yard, S.W., 3 p.m. Captain Lord Charles Beresford, "Machine Guns."

Philological, University College, W.C., 8 p.m.

SATURDAY, JUNE 16...Geologists' Association. Excursion to Deneholes, near Gray's Thurrock (in connection with the Essex Field Club), under the direction of Mr. T. V. Holmes.

Journal of the Society of Arts.

No. 1,595. Vol. XXXII.

FRIDAY, JUNE 15, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Twenty-ninth Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurer's statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new Members, will be held, in accordance with the Bye-laws, on Wednesday, the 27th of June, at 4 p.m.

(By order of the Council)
H. Trueman Wood,
Secretary.

CONVERSAZIONE.

The Society's Annual Conversazione will be held this year in the Buildings of the International Fisheries Exhibition. His Royal Highness the Prince of Wales, President of the Society, has intimated his intention to be present.

The precise date will be announced in the next number of the *Journal*. Cards of invitation will be issued to the members of the Society in due course. Each member will, as usual, receive a card for himself and a lady.

MEDALS.

The Council have awarded the Society's Silver Medals to the following readers of papers during the Session 1882-3 :—

To D. Pidgeon, for his paper on "Recent Improvements in Agricultural Machinery."

To A. J. Hipkins, for his paper on "The History of the Pianoforte."

To Alexander Siemens and Edward Hopkinson, D.Sc., for their papers, I. "The Transmission of Power by Electricity." II. "The Portrush Electrical Railway."

To Captain Douglas Galton, C.B., F.R.S., for his paper on the "Economy of Sanitation."

To F. Seymour Haden, F.R.C.S., for his paper on "The Relative Claims of Etching and Engraving to Rank as Fine Arts."

To Edmond O'Donovan, for his paper on "Life Among the Turcoman Nomads."

To Colonel Bateman Champain, R.E., for his paper on "The Trade Routes of Persia."

To W. S. Seton-Karr, for his paper on "Agriculture in Lower Bengal."

To W. G. Pedder, for his paper on "Historical Development of the Different Settlement Systems of British India."

Thanks were voted to the following Members of Council, and to the Secretary, for the papers read by them :—

To Sir Frederick Bramwell, F.R.S., Vice-President of the Society, "The Society of Arts Patent Bill, and some Points in American Patent Law and Practice bearing thereon."

To W. H. Preece, F.R.S., Member of Council, for his paper on "Electrical Exhibitions."

To H. Trueman Wood, B.A., Secretary of the Society, for his paper on "The Government Patent Bill."

SWINEY PRIZE.

The Council have to give notice that the next award of this prize will be in January next. Dr. Swiney died in 1844, and in his will he left the sum of £5,000 Consols to the Society of Arts for the purpose of presenting a prize, every fifth anniversary of the testator's death, to the author of the best published work on Jurisprudence. The prize is a cup value £100, and money to the same amount; the award is made jointly by the Society of Arts and the College of Physicians. The cup now given is made after a design specially prepared in 1849 for the first award, by D. Maclise, R.A. Any person desiring to submit a work in competition, or to recommend any work for the consideration of the judges, should do so by letter addressed to the Secretary of the Society.

Proceedings of the Society.

FOREIGN AND COLONIAL SECTION.

Tuesday, May 29th, 1883; W. McCULLAGH TORRENS, M.P., in the chair.

The paper read was—

QUEENSLAND: ITS PROGRESS AND RESOURCES.

By ARTHUR J. STANESBY.

The colony which forms the subject of this evening's paper is one of the youngest of Britain's offspring, but is rising so rapidly into a position of international importance, that I feel very great diffidence in attempting, in the short time at my disposal, the task of giving my audience an adequate notion of its vast resources and rapid national growth.

If I am to hope for the smallest degree of success in my undertaking, I must waste no time in prefatory remarks, but must plunge into the subject-matter of the paper at once. I would, however, remark, in answer to a question which may arise in the minds of some of my audience, that in speaking of Queensland, her progress and prospects, I am only stating facts as they have impressed me during a stay of some years in the colony, and if I display any enthusiasm in writing of Queensland, it is enthusiasm born of gratitude to a colony which proved a kind foster-mother to me, and whose arms are always open to welcome those who seek a home with her.

I must remind my audience that Queensland is a very large country, having an area of about 670,000 square miles, nearly as great as that of France, Germany, and Austria combined, while its population is under 300,000, or less than that of Birmingham.

These facts being borne in mind, it will readily be understoood that the present development of the colony is small indeed, in proportion to its capabilities; and now that Great Britain and Ireland, and, indeed, European countries generally, are feeling the necessity of finding suitable outlets for their redundant populations, surely no apology is needed for calling attention to the vast and attractive portions of our Colonial Empire, which are positively pleading for people to go and live in them, and to enjoy the many advantages they have to offer.

It is only as recently as 1859, when it was separated from New South Wales, that Queensland became a distinct colony. Before that time, the territory it comprises retained the name of the Moreton Bay District, which had been bestowed upon it in 1770 by Captain Cook, in honour of the Earl of Moreton (President of the Royal Society), and, up to that time, very little was known of its resources, even in the other Australian colonies, and still less in England. The wisdom of that separation has been amply vindicated, I take it, by the vigorous progress of the colony from its very birth. On reference to statistics, which, by the way, I mean to avoid as much possible this evening, I find that in the year following the separation, the imports of the infant colony are set down as being of the value of £742,023, and the exports as £523,476, while the latest returns which I have seen—and which are for the year 1881—give £3,601,906, or £15 17s. 5d. per head of population, as the value of the imports; and £3,289,253, or £14 9s. 10d. per head, for the exports. It should be remembered that these figures indicate no sudden spurt of prosperity consequent on the discovery of goldfields or any such cause, but a steadily increasing rate of progress. The revenue, according to the latest available returns, was £2,102,094 17s. 4d. for the year ending June 30, 1882.

I have merely quoted these figures in commencing my remarks in order to show, inferentially, how great a future Queensland must have, when with so small a population she has been able to accomplish so much; for I would submit that such a country as Queensland must advance in wealth in proportion as it becomes less sparsely peopled. In a country dependent for the prosperity of its inhabitants on its manufacturing industries, and the demand from outside for its goods, a dense population may become a misfortune, but in the early history of a fertile land, possessed of apparently inexhaustible mineral riches, population is the one great want.

In weighing the comparative attractions offered by the various fields for emigration and settlement, no consideration takes precedence (for the most numerous and desirable class of intending emigrants at least) of the question —"What system of land laws has the colony adopted; and what are the facilities it offers for the acquirement of land?"

Now, I believe most people who have visited, as I have done, several of the Australian Colonies, would agree with me in saying that,

if Queensland has not attained to perfection in her land legislation, she has, at least, profited by the experience of older colonies, and avoided serious errors in this matter which have injured them. Of all legislation, land legislation presents, and always has done, the most difficult problem law-makers, are called on to solve. Queensland, however, had a pretty fair start in this matter; and being untrammelled by precedent, and having the consequences of unwise legislation in other colonies full in view, has, I believe, succeeded remarkably well in adjusting the land laws to the varied necessities of its inhabitants.

There are two great classes of claimants for land in a new colony. The graziers, or squatters as they are called, and the farmers. It is by the former class that the land of a colony is first explored and its richness made known. This must always be the case, for at first there are no means of transit for produce from the interior land of the colony to the towns on the seaboard, where alone produce may find a market, or means of export to a market. It would be useless for the farmer to raise crops for which, owing to these causes, he could find no market; but the grazier can drive his flocks and herds any distance to market, feeding and even fattening them on the land they have to traverse. The grazier then first occupies the land, and as, for his operations to be remunerative, he requires large areas, the land is, as soon as is practicable, roughly surveyed into large blocks, and these blocks, or runs as they are called, are leased to him by the Crown on easy terms, which include provisions for the acquirement by the lessee of the fee simple of comparatively small portions of his leased run, on which he may erect his residence, and the various buildings necessary for the carrying on of the operations of a cattle or sheep farm. The terms of squatters' leases must and should be easy, for it is by their energy and enterprise alone that the land can be utilised at first; and though it is true that many men of this class have realised handsome and even colossal fortunes, it must be remembered that they have had hardships to undergo, and privations to endure, in the early times of the colony, which deserve substantial reward, and very many have toiled just as hard, but have never reached the goal, losing their lives in the work of opening up for those who have followed them the wealth they have not survived to enjoy. I am led into this explanation of squatters and their estates, because any one travelling in any of the Australian Colonies is accustomed to hear this class spoken of sometimes as if they had possessed themselves of large tracts of land by unfair means, and were hindering the settlement of the country. This is not so, in Queensland at any rate. The Government reserve to themselves the right to resume at, I think, six months' notice, the whole or any portions of the leased blocks at their discretion, and are thus enabled to supply the ever-increasing demand for freehold homesteads and farms.

As a new colony becomes populated, a demand arises for farms of smaller dimensions. Besides the immigrants who arrive with capital sufficient to buy farms, many of the squatters' *employés*, having acquired both experience and capital, desire holdings of their own, by which they may attain to that position of independence, which is the aim of every enterprising colonist. To meet this demand, the Government of Queensland has devised regulations for the sale of land, which are intended to meet all the requirements of the various classes of buyers. It would be useless for me to try to explain the nature of all these regulations, as they are necessarily numerous, but if I give a few particulars, it will, I think, be acknowledged that they evidence a desire, on the part of the Queensland Government, to facilitate the settlement of the colony. I would refer those who require more detailed particulars on these points to the Agent-General's office in London, which is always ready to supply inquirers with the fullest information about the colony.

It would astonish any one unacquainted with the subject to learn upon what widely different principles the various colonies of Australasia have framed their land laws. The Imperial Government, taught by past history the inexpediency of unnecessary interference in the internal management of the British colonies, has left them perfect freedom to deal with their land (which is at first their only capital) entirely according to their own notions, and the consequence is seen in the different systems of land legislation adopted by these colonies. In one colony, for instance, a fixed upset price is put upon all the land, and colonists are invited to purchase freeholds, taking what, and as much, land as they desire and can pay for; no condition of any kind (except, perhaps, as to minerals) being attached to their purchase. This system has not worked well. It is easy to understand that, with such a law, the best lands of the colony speedily pass into private hands at a price below their value, while the

inferior portions fail to find purchasers at the same price, being worth less. And, besides, such a system fails to take cognisance of the fact that the object of the colony is not merely to raise capital by the sale of its land, but also to settle a population thereon, and to secure that it should be made, by its productiveness, to contribute in after years as much as possible to the wealth of the country.

Another colony adopts the plan of allowing what is known as "free selection before survey." This means that a person wanting a piece of land for a farm, or any other purpose, has the right to select what he requires, with certain limits as to area, from any of the land which, as I have explained, is leased by the Crown to the squatters, and, by performing certain prescribed conditions as to residence and improvements, the selector becomes the owner of such land, paying to the Government interest on the price so long as that remains unpaid. This scheme seems more plausible than the former, but works badly in several ways. It leads to what is known as dummying. Suppose I am the lessee of a tract of land, which I devote to sheep or cattle rearing. Under such a law, my first care will be to ascertain what portions of my run are most valuable to me or are most likely to be "selected" by others. These parts I must, for my own protection, select myself. But the law only allows me to select a limited area, and demands my residence on my selection; so as it is plain I cannot reside, or rather make an affidavit that I have resided, in a dozen places at once, I select what I can myself, and then my sons and my daughters, my servants, my friends, anybody, indeed, that I think I can trust, becomes a dummy for me. They select the land in their names, I provide the money. They reside on the selection, or, what is more to the purpose, declare that they have resided on it. As soon as the time of enforced residence expires, they apply for a Crown grant of the land, and I pay the price.

Having got the grant, they, if they are honest to me, transfer the land to me; if they betray me, I cannot enforce my claim, and must buy them out, or let them ruin my run by retaining the selections. But suppose I am a *bona-fide* selector; how does the law help me? Let us see. I choose a piece of land to suit me. It is situated on the run of some squatter—perhaps in a part of the run very important to him. He is naturally vexed at my settling on that particular spot. He knows the country wants settling, but the settlers need not choose his leased land for the purpose. What does he do? This is what he can do. He can select, by the use of dummies, the land all round my selection, shutting me out entirely from all chance of having neighbours, perhaps cutting me off from my water supply, and impounding all my stock which chance to stray off my yet unfenced land, and so causing me endless annoyance and loss. We will suppose one other case to show how this free selection, as it it called, works. I am a squatter, an upright man, so upright indeed as to scorn to protect myself by dummying. (Need I say, under a system like this, such a squatter would be a *rara avis*.) There are certain spots on my run which are of special value to me, if to no one else. My cattle-camps, for instance, are places to which my cattle have been trained to run, when frightened off the hill-sides and out of the ravines by the sound of the stock whip. I discharge from my service one of my stockmen, a man who knows all about my run and my mode of working my cattle. He avenges his discharge by selecting one of these cattle-camps. He knows my cattle cannot be kept off that particular piece of land, and if they could, he and his mates would see to it that they should be frightened on to it, and then he impounds my cattle, and lives on the driving expenses which I have to pay to release them. This goes on as long as I can bear it, and then I buy him out.

None of these cases which I have instanced are very extreme. I have known many such under the system of "free selection before survey." Perhaps it may be asked why I take so much trouble to explain what happens out of Queensland. It is because thereby will be better understood the wisdom of the system adopted by the colony to which I am directing attention. In Queensland, speaking broadly, the Government itself decides what portions of land it is desirable to settle, and allows no one else the power of interfering with the leased lands. Having decided that a demand exists in a certain district for land, for agricultural or small-farm purposes (I use the latter term to distinguish the freehold plots of grazing land from the larger leased runs), notice is given to the graziers, of whose runs the desired land forms a part, that the Government is about to resume possession, and terminate the lease of such land. The resumed area is then surveyed, and classed as agricultural, to be sold at 15s. per acre; first class pastoral, at 10s.; and second class pastoral, at 5s.

The payment of the purchase money can be

spread, if the buyer chooses, over ten years, no interest being charged; that is, he pays yearly, for these ten years, eighteen pence an acre for agricultural, one shilling for first class, and sixpence for second class pastoral land. As he will require a larger amount of land to make a living on if it is poor than if it is the best, he is allowed to buy from 80 to 5,120 acres of the least valuable, from 80 to 2,500 of the medium, and from 40 to 640 of the best. The prices I have quoted do not include survey fees, which, however, are not heavy. The buyer on these terms must improve the agricultural land to the extent of 10s., and the inferior to that of 5s. per acre; but he can please himself as to the nature of the improvements, provided they are of *bona-fide* value, and he must reside on the land. He can escape this last condition by cultivating not less than a tenth of his holding. After three years, he has the right to dispose of the land as his own, and can, if he choose, pay up the instalments, and receive a freehold Crown grant of his estate.

To those content with smaller holdings than these I have described, the "Homestead Areas Act" offers even better terms, under which 160 acres of agricultural land can be purchased at a total cost of £20. These homestead blocks are specially secured to the holders against seizure for debt, and they have other advantages which my time will not allow me to specify in this paper. I may mention, however, that as the railways of the colony are extended, a considerable extent of country on each side of the line is reserved for homestead areas.

I must mention one important effect of the Queensland land laws on that colony, as compared with its neighbours. In some of the other colonies, one finds a great many townships, but very few towns worthy the name. The Queensland system of proclaimed areas produces groups of settlers comparatively close together, and this tends to the natural growth of towns of important size, and renders it easier and better worth while for the Government to extend all kinds of advantages to the towns which they could not otherwise enjoy. For instance, every town in the settled districts of Queensland has its state school or schools, post and telegraph offices, and police-court, while most have a Resident Government Land Agent's Office, besides various institutions, partially supported by the State, such as hospitals, literary institutes, &c. Churches of all denominations abound. All are on the same footing, being unsupported by the State, except as far as a gift of land is concerned, and this privilege is extended to all denominations of sufficient numerical strength to claim it.

Having attempted to give some indication of the facilities for procuring land in Queensland, I will now endeavour to enumerate some of the ways in which that land may be utilised.

The most important product of Queensland, measuring its importance by its money value, is wool. The amount of wool exported by the colony, in the year 1881, was valued at £1,331,869. It was formerly thought that the climate of Queensland, or at any rate that of the Northern portion of the colony, would prove too warm for successful sheep-farming. That this idea was erroneous has been proved long since, and no doubt many persons will remember having seen in the International exhibitions, of late years, exhibits of Queensland wool, the quality of which considerably surprised those unacquainted with the colony. The favourite breed of sheep is the pure merino, but some coarse-wooled varieties are growing in favour, and crossed breeds have been successfully introduced in many parts. Sheep-rearing is an industry requiring considerable capital and special knowledge, and any elaborate dissertation on it would be outside the objects of this paper. I may, however, confidently assure those with the requisite capital and knowledge, that they will find ample scope for both in Queensland; and that the life of a country gentleman has its pleasures in that colony, as well as in England.

I need hardly say that Queensland offers abundant advantages to the cattle-farmer. Its enormous area, much of it still unexplored and unsettled, must, for years to come, attract to the colony those hardy pioneers of civilisation who are ever on the look-out for what they call new country. The work of exploration is continually being carried on in Queensland, and it is from those who undertake it that we hear every now and then of discovered traces of the ill-fated Dr. Leichhardt and other heroic spirits, who carrying, as it were, their lives in their hands, first made known to the world the richness and fertility of interior Australia. The results of cattle-farming in Queensland do not show very strongly on paper in the lists of exports, and no adequate conception of the extent of the industry can be formed by noting the quantities of meat, fresh and preserved, hides and tallow, in that list; for the reason that the cattle trade of Queensland is principally overland with the neigh-

bouring colonies, the meat preserving establishments in Queensland being at present few, and the frozen meat trade being as yet in a very undeveloped condition. Sufficient, however, has been done in this way to demonstrate clearly that supplies of meat, both frozen and preserved, can be exported by Queensland as profitably as by the other Australian colonies. At the end of the year 1881, it was estimated that the Queensland herds of cattle amounted to 3,572,247 head, and the number is continually increasing.

The sugar-growing industry in Queensland has, no doubt, a great future before it. The deposits of rich alluvial soil on the river banks of the colony, aided by a suitable climate, have already rendered Queensland a formidable rival to the Mauritius, and the other spots from whence, a few years ago, we were accustomed to think good cane sugar could alone be obtained. According to the latest return I have seen, there were in 1882, 22,143 acres of land under sugar cane. The produce, however, of only 15,550 acres was crushed, producing 19,051 tons of sugar, or an average yield of sugar per acre of 1 ton. 4 cwts. 2 qrs. As compared with the previous year, this is an increase of 4,622 acres under cultivation, and of 3,487 tons of sugar produced. It is chiefly on the sugar plantations that the Polynesian or Kanaka labour is employed, about which we hear every now and again from some well-meaning philanthropists. Whenever I read the remarks of those who denounce the employment of Kanaka labour, as it is conducted in Queensland, and who speak of it as little better than slave trade, I cannot but regret that so much good feeling is so misdirected; and I feel certain that anyone who has seen these South Sea Islanders during their term of service in Queensland, will be inclined to agree with them in thinking that they never were better off in their lives, nor are ever likely to be. Solitary instances of abuse of power by those who bring these men from their homes (and I submit these instances are very few and far between), should not be allowed to prejudice a system of importation of labour which is so beneficial in its effects to the colony and to the labourers themselves, and which is fenced round with the most stringent regulations possible, faithfully enforced by the Colonial and Imperial Governments.

These islanders are brought to Queensland by their own consent, to do work for which they are well fitted. Their employers are compelled to treat them properly during their stay in the colony, and to provide them with conveyance back to their homes at its expiration. When their term of service is over, one sees detachments of them in the coast towns waiting for embarkation, and as they stroll about the streets linked to one another by their little fingers (which is their equivalent to the English fashion of arm-taking), gazing at the shops and sights of town, well-clothed, happy and contented, the spectator has need to wonder if these are the unfortunate kidnapped creatures about whose wrongs he has read occasionally in the correspondence columns of home newspapers. The terms on which these Polynesians are employed are briefly these :—The period of service is limited to three years; the employer must provide the labourers, during that time, with food, according to a liberal dietary scale arranged for the purpose, and with clothes; he must also pay them, in cash, for their labour, at the rate of £6 per year. For myself, I feel convinced that the experience of civilisation which they obtain during their sojourn, cannot but be beneficial to them for the rest of their lives, and also to the savage communities to which they return.

It might at first be supposed that the employment of Polynesians on sugar plantations would have the effect of ousting European labour, but this is not the case. The more of this coloured labour that the planter avails himself of, the larger is the staff of Europeans that becomes necessary. In the Mackay district, in the north, for instance, the experience of five years shows an increase of 1,221 Europeans, to balance that of 753 Polynesians during the same period.

The price of land suitable for the cultivation of the sugar-cane is 20s. per acre, payable in instalments spread over ten years; and to prevent the alienation of such land in greater quantities than can be properly worked, the extent of the blocks sold for that purpose is limited to 1,280 acres.

I have given prominence in my remarks to sugar-growing, because I believe that this industry is destined, in a very short time, to become perhaps the most important to the world at large of any in the colony; but for the ordinary farming operations, as understood and practised by the British agriculturist, Queensland offers as fine a field as any part of the world. Extending as it does through so many degrees of latitude, it goes without saying that the adaptability of its soil for particular crops is different in different parts. In the southern

portion of the colony is the magnificent agricultural district of the Darling Downs, where wheat and other cereals, and all the root crops dear to the English farmer, are produced in quantity and quality as good as could be desired. I will not weary my audience with quotations of the yield per acre of the various crops: such figures are easily accessible to any one desiring to study them, and I should be talking of what I very imperfectly understand. But one needs no special knowledge of agriculture to be able to form an opinion—from having seen the products of the Darling Downs farms at the agricultural shows held annually in all the towns in this part of the colony—that there is nothing in the list of English agricultural products which cannot be successfully cultivated there; while maize, and the vine, and many semi-tropical fruits, which cannot be raised by the British farmer, are there produced with the minimum of labour.

When I read the late Mr. Anthony Trollope's description of the Queensland farmer, in which he says: — "He is almost invariably a struggling man, with small means, who grows a little Indian corn which he barters with shop-keepers for other goods, having no market in which he can get money for it," then I know that the gifted writer could have had no practical acquaintance with the farming population around such towns as Toowoomba, Warwick, Dalby, or Roma.

Situated upon the Southern and Western line of railway, which offers facilities for the conveyance of farm produce to the metropolis (Brisbane), these towns and others are steadily and rapidly growing in wealth and importance. Their fine streets, with well-built stores, hotels, banks, and offices, attest the fact that they are centres of a firmly established and growing trade. They have each their two newspapers (for the most part bi-weekly), their literary institutions, schools, and churches, worthy of any of the agricultural centres of England. In the neighbourhood of the towns I have mentioned, extensive vineyards are cultivated, and the wines produced in this district are considered by many to be equal to the best Rhenish productions. However this may be, the vignerons of Queensland are decidedly prosperous, and every year sees additional acreage devoted to the growth of the vine.

Perhaps the best idea of the capabilities of Queensland soil and climate can be formed from an inspection of the fine Botanical Gardens in Brisbane, where, under the able direction of Mr. Walter Hill, the curator, are cultivated, in a small space, a host of plants, representative of nearly every part of the world. Cotton, flax, coffee, spices of various kinds, and even tea, may there be seen in a flourishing condition, in a collection to enumerate which would take me more than the whole evening. Considerable progress has already been made in the cultivation of cotton and tobacco in Queensland, and both of these industries are likely to become important. In the year 1882, the yield of ginned cotton in the colony was 183,488 lbs., the produce of 973 acres under cultivation. This return shows an increase of yield, as compared with the previous year, of 57,752 lbs., 354 acres of land having been applied to this use more than in 1881.

I think few English people are aware how rich in valuable minerals is the colony that is under review. Gold, silver, tin, copper, lead, antimony, manganese, iron, marble, and though last, by no means least, coal, have been already proved to exist in large quantities.

Gold mining affords employment to a large number of people in Queensland, and though the names of its gold-fields do not stand out so prominently as the better known and more proved fields of other colonies, yet a large amount of the most precious of the metals is continually being brought to light. The yield of gold is more variable than that of most other metals. The value of the gold annually raised in Queensland during the last few years has varied from under a million to over a million and a-half pounds sterling. It is estimated that from 1867 to the end of 1881 the gold exported from Queensland amounted to 3,783,810 ounces, valued at £13,243,335.

The mining regulations are framed so as to encourage the exertions of the individual miner as well as those of the joint-stock companies, which employ a large amount of capital in their search for the precious metal. Immense areas of auriferous land have been discovered of late years in the north-east of the colony, and there can be no doubt that many remain to be discovered. The largest nugget yet found in Queensland was at Gympie, in the south of the colony. It weighed nearly 100 lbs., was valued at £4,000, and was found quite near the surface of the ground.

Wherever gold is to be found in the New World, one also finds the Chinaman, and it is so in Queensland. At the last census, there were 11,229 male Chinese counted, and

23 females. They are not very desirable colonists, and the disproportion these numbers show between the sexes indicates plainly enough that they do not come to Queensland to settle down. That is, in fact, the greatest objection to them. The colonists say they swarm to the gold diggings like flies to a honey-pot, get all they can, and return to China to spend their gains; and those who settle in the towns horde together in a manner highly detrimental to the public health. They are especially disliked by the working men, because they work for wages on which a European could not maintain himself, much less a family. In matters of labour they are singularly devoid of pride—some would say of self-respect—the most menial domestic duties being undertaken by them. Laundry work seems to be one of their specialities.

To check the immigration of the Chinese, a poll-tax is levied upon every Chinaman coming to the colony. This provision forces them to contribute to the revenue, which they would not help much in any other way, but they still continue to arrive in large numbers. This is only possible on account of the wonderful appreciation by the Chinese of the power of co-operation. By its aid, the redundant populations of the Chinese ports are sent in shiploads to various parts of Australasia and America, their passages and taxes being paid by bodies of their countrymen, with whom the emigrants have entered into contracts providing for the repayment of the sums advanced. And, I believe, these contracts are rigidly fulfilled by the debtors, almost without exception, though what is the occult force which binds them to the performance of their promises when they have landed in a free country, is not apparent.

Rich deposits of copper and tin have been discovered in Queensland, and will figure with increasing importance in the list of exports in future years. Coal has been proved to exist in many parts of the colony, and though in a backward state at present, it is evident that the coal-mining industry is only awaiting the influx of capital and population to become a great source of wealth to the community.

In addition to the pastoral, agricultural, and mining industries, Queensland has some which are of considerable importance, though less heard of. Pearl-fishing is carried on along the north coast. The Bêche de Mer fishery also employs many hands, as does the catching of the dugong, a fish which yields an oil of great medicinal value, and similar to cod-liver oil. In these fishing industries, the principal labour is performed by aboriginal Australians, or Polynesians, but numerous small steamers and sailing vessels are constantly engaged in the trade, and the product goes to swell the wealth of the colony.

A small book, entitled "The Resources of Queensland," published by Messrs. Silver and Co., contains, in a compendious form, a mass of information about the products of the colony. I would commend it to the attention of anyone who is anxious to obtain information of the kind, as a very reliable work.

I have endeavoured to glance briefly at the principal producing industries of Queensland, and if I said nothing about its manufactures, it might be supposed that none existed. This is not so. At a public meeting in Sydney, I once heard Sir Henry Parkes, then the Premier of New South Wales, say, in advocating the adoption of a Free Trade policy in that colony, that "the most legitimate and natural function of a new land like Australia was to add to the world's wealth by production of material, rather than to enter into competition with older countries in manufacturing;" and I think you will agree with him in that sentiment The attitude of the Queenslanders in this matter appears to have been this, "By all means let us have manufactures; but let them be the natural outcome of our needs. If they can only exist by being bolstered up with protective duties, let us turn our attention to other matters." At any rate, this is the line of action they have adopted, and the results are decidedly encouraging. Many manufacturing industries are gradually growing up in the larger towns, and their very existence unprotected is a proof of their usefulness to the colony.

Were it not for the conviction I have that Queensland is very little known to English people, it would never occur to me to speak of the social condition of the colony. If we in England enjoy any social advantages from which the Queenslanders are debarred, I do not know what they are. Perhaps the fashions of ladies' dresses there are a month or two behind those of Paris or London, though I should doubt that. I sometimes hear people discussing Australia as if the inhabitants lived a semi-savage or, at any rate, an only semi-civilised life. If they think so, they are immensely mistaken. If such persons could be dropped miraculously into the midst of a dinner party in any of the town or country mansions of Queensland, I do not think they would find

the guests committing any more *gaucheries* than would be witnessed in an English assembly of the same kind. The most noticeable difference would probably be the presence on the table of semi-tropical fruits which did not cost the host a guinea a dish.

In a London evening newspaper, lately, I read an article on Queensland, containing a great deal of information about the colony, and some useful hints to intending emigrants; but when the writer recommended them, among other things, to take out with them firearms and quinine, I felt convinced that his knowledge of the country about which he was writing was not the result of personal experience. What are the firearms for, I wonder! Life and property are as secure in Queensland as in any part of the great empire to which it belongs, and people there, except when on an exploring expedition into the unknown parts of the interior, would no more dream of arming themselves for their defence than would a Londoner of walking down Piccadilly with revolvers in his belt. The suggestion as to quinine is more easily understood, for I have found that, even in the neighbouring colonies, an impression prevails that every one visiting Queensland will, as a matter of course, have an attack of fever and ague. I have been repeatedly asked by people in New South Wales and Victoria, who knew I had been in Queensland—"Did you have the fever and ague?" and I was always exceedingly vexed to have to confess that I had experienced that malady, because I felt that I was confirming in them a wrong impression. The simple fact is, that those who choose to go, as I did, into the unsettled parts of Queensland, camping out—sometimes under a tent, but oftener without one—drinking stagnant water occasionally, and altogether disregarding their health in pursuit of gain or adventure, are very likely to be attacked, sooner or later, by what is called fever and ague, the popular remedy for which is quinine. But the great majority of the inhabitants of Queensland lead as gentle lives as those engaged in similar occupations in England, and find the climate of the colony as healthy as that of most other places.

To form any correct estimate of the prospective importance of Queensland, it will be necessary to take into consideration its geographical position as well as its resources. In closing this paper, therefore, I shall endeavour to glance briefly at a few important facts in this direction. Queensland comprises the whole of the north-eastern portion of the great continent of Australia, and has about 2,300 miles of sea-coast. As to its rivers, those to the east of the Great Dividing Range (which traverses the colony through its entire length from north to south), are, though numerous, of small commercial importance; for, owing to the proximity to the coast of the mountain range in which they rise, they are of inconsiderable length, and for the most part unsuitable for navigation. Of those draining the western slope, some flow southwards through New South Wales, and others northwards into the Gulf of Carpentaria. Queensland is bounded on the west by the northern territory of the colony of South Australia; on the south by New South Wales; on the east by the Pacific Ocean; and on the north by Torres Straits and the Gulf of Carpentaria, a part of the Indian Ocean. For the purposes of the large trade already arising with China and India, its position is much more convenient than that of its neighbour colonies, and it is also favoured by being the nearest portion of Australia to the great western seaports of America. Queensland has a well-organised mail service of its own, which takes the northern route through Torres Straits into the Indian Ocean, thus effecting a considerable saving of time.

The narrow Torres Straits alone separate Queensland from the island of New Guinea, about the annexation of which so much has been said during the last few weeks or so. So little is really known, as yet, as to what has actually been done, or what is intended to be done, about this annexation, that it would, I feel, be presumption on my part to enter upon any discussion as to the wisdom or otherwise of the proposed course of action; but I suppose the correspondence which has appeared in the English newspapers on the subject is fair matter for comment. Whether the annexation is carried out or not, it is evident that it is to Queensland that the question is of most importance, and for very different reasons from some that have been assigned in the newspaper correspondence to which I refer. I think the key to the action of Queensland in this matter is to be found in the fact that the colony has already felt the baneful effect of having for a neighbour the French penal settlement at New Caledonia, and in the knowledge that nothing is more probable than that, at no distant date, New Guinea, if left alone by the Australian Colonies, will be taken possession of by some foreign power,

and that it would then most likely be utilised as a penal settlement.

Penal settlements are an especially sore point with the Australians. In times which though past are not forgotten, they have felt the ill-effects of having such settlements in their midst, placed there by their own nation. They are now feeling the annoyance of the French one at New Caledonia, though a thousand miles of sea separates that island from the Australian coast. Is it, then, to be wondered at that Australians generally, but especially Queenslanders, view with dread the probability of the establishment of another such settlement by a foreign power on an island only separated from them by a narrow strait. Apart from this contingency, the presence of a foreign colony so near to Queensland would have the most disastrous effect on the latter. The necessity which would immediately arise for a large expenditure, to maintain a sufficient defence for its enormous extent of coast, would inevitably have the effect of crippling, for a long time to come, the development of its resources, which is at present proceeding so satisfactorily. The idea put forward lately, that the annexation of New Guinea is desired by the sugar-planters of Queensland, in order that they may obtain from that island a supply of labourers from the plantations, is altogether erroneous. In the number of the *Queenslander* (an excellent weekly newspaper, published in Brisbane), for March 31 last, appears a letter from a missionary in New Guinea. Its contents show plainly enough that the New Guineans are altogether averse to leaving their own land, even for a few months; and the planters of Queensland know this perfectly well, and that they could expect to get no labourers from that island.

Many statements, of a very damaging character if true, have lately been made about the treatment of aborigines by the Government of Queensland. Fortunately for the good name of the colony, the refutation of such statements has not been left to such feeble authority as mine. Sir Charles Lilley, the universally respected Chief Justice of the colony, arrived in England the other day, in time to give a categorical denial, in a letter to the *Times* of May 23rd, to the assertion that the evidence of aboriginals is not received in the courts of justice of the colony, and he further shows that, in matters which come before the courts, the interests of aboriginals are specially protected at the cost of the State.

I am obliged for the patience with which this paper has been listened to, and I venture to express a hope that, in the discussion which is to follow, some of the gentlemen present, who are acquainted with the colony, will supply some of the omissions which I have made in my attempt to give an account of the progress and resources of Queensland.

DISCUSSION.

Mr. Pfoundes said he must remark, in reference to one passage in the paper, that the occult tie which bound the Chinaman was the family and patriotic tie. All Chinamen had great respect for their family duties and love for their native land, and desired to return to it, dead or alive. On one occasion, he remembered a voyage in which a large part of the cargo consisted of dead Chinamen being conveyed home from Melbourne. Capitalists in China, therefore, had a powerful hold over those who left the country with their assistance, and who not only repaid the debt, but greatly aided their families who were left behind. No notice had been taken in the paper of the aborigines, who, when he remembered Queensland, which was a good many years ago, were stated by the settlers to be very fierce, so that he was not at all surprised at the advice to emigrants to carry firearms. Whether it was the same now he could not say; they might have become more peaceful, or the young Queenslanders might have improved them off the face of the earth. With regard to what was called the "Blackbird" traffic, he knew it was rather a delicate subject with Queenslanders; and, though he did not belong to the Exeter-hall platform, he would say that he knew very bad things sometimes happened in Australia in years gone by, and he hoped, for the credit of Queensland, that a better state of things now existed. It occurred to him that, if labour were required, it might be obtained in abundance from China, and in the shape, too, of skilful agriculturists, if proper guarantees and fair terms were offered.

Mr. Archer (Agent-General for Queensland) had much pleasure, on behalf of the colony he represented, in thanking Mr. Stanesby for the able and interesting paper he had read. He had not the pleasure of knowing him personally, but he should judge from the paper that he was an experienced colonist, and, from its impartial and calm tone, it carried the stamp of truth upon its face. He (Mr. Archer) was probably one of the oldest Queenslanders in London, for it was nearly 50 years since he left England to take up his abode in Australia; and after two years in New South Wales, he made his way to what was now called Queensland, though it did not acquire that name for more than 15 years after he went there. Mr. Stanesby had handled very ably the much vexed question of coloured labour, a

question which was almost incomprehensible to those who were not conversant with the facts. The impression of a large, enthusiastic, and very honest party in this country was that this coloured labour was only another name for slavery, but no greater fallacy was ever invented. He could only say that if the coloured labourers in Queensland were slaves, England was full of slaves; every man who bound himself to perform a contract, and every apprentice in England, was a slave. These men were engaged, under Government supervision, for three years at fixed wages; they had certain rights, which their employers were bound under securities to perform towards them; for instance, to send them home at the end of three years, if they wished, which three-fourths of them did, and to find them in everything, including food, clothes, and medical attendance. If the philanthropic people who busied themselves about improving the condition of the coloured labourer in Queensland would turn their attention nearer home, and would raise the condition of the unskilled labouring men in England to anything like the prosperity and independence of these coloured labourers, they would be doing much more good; and when they had done that, they might go to a class lower still, and improve the mass of humanity festering under their noses at the East-end of London, which was a disgrace to any civilised country; they might then go to Queensland with a clear conscience, and show how coloured labourers should be treated.

Mr. BONIFACIO thought there was a general impression, amongst those who had only derived their information from the newspapers, that it was not so much the treatment which the coloured men received in Queensland, which constituted the objection to this kind of labour, but the mode in which they were impressed into the service on the islands.

Sir CHARLES LILLEY said he was not much surprised, on his arrival in this country, to find that the subject of coloured labour, and the mode of procuring it by the planters of Queensland, had excited a considerable discussion. In passing through America, he heard for the first time that the very bold step had been taken by his brother colonists of annexing, or attempting to annex, the country of New Guinea, and he imagined at once, knowing the state of party feeling in the colony, that a cry would be raised here by amiable, but in most cases mistaken, enthusiasts, that the step had been taken solely with a view to obtain coloured labour by the planters of Queensland. Mr. Stanesby had stated, with considerable force and truth, what he believed to have been the true reason for that attempt at annexation. He knew, as Chief Justice of the colony, how the proximity of New Caledonia had been a source of heart-burning and trouble. Notwithstanding the great distance, they had constantly instances of murderers, and other criminals of the deepest dye, escaping from New Caledonia to Queensland, and they had had the trouble and expense of arresting them, detaining them, and sending them back; and it was only with great difficulty, and through pressure brought to bear by the Imperial Government, that they prevailed on the French Government to assist in the matter. They could easily imagine how this difficulty would be aggravated if, within 40 or 60 miles, an enormous country like New Guinea were annexed by a foreign Government, and converted into a penal settlement. So far as any intention on the part of the planters was concerned, though, of course, he could not speak for every individual of so large a class, of getting coloured labour from New Guinea, he was quite sure that it was not entertained, or if it were, it would be disappointed. Those people were exceedingly fierce; they cultivated the land, and lived in villages, and would be the most unlikely people in the world to be induced to emigrate to Queensland. It was mainly to prevent annoyance from the presence of a foreign power, that the Government of Queensland had attempted to annex New Guinea. Speaking not only as the Chief Justice, but as an Australian statesman of many years' experience, he could say that it had always been a favourite idea that New Guinea should be under the dominion either of the Imperial Government or of the Australian people. An immense trade was already springing up between Queensland and Australia generally, and China; and India was now coming into the market with her teas, so that it was a matter of the first importance that New Guinea, which lay in the direct highway, should belong either to England or to Australia herself. The Queensland mail went by way of Torres Straits, and would be entirely at the mercy of any foreign power which might seize on New Guinea. As to the way in which the annexation should be effected, or the general policy of the step, it was not his business to offer any comment, though he had his own views on the subject. With regard to the question which had been asked as to the mode of obtaining coloured labour, in so far as the law could possibly secure the honest inspection of those contracts with the coloured labourer in his own country, every effort was made. The ship and captain were licensed by the governor of one of the Australian colonies; the labourers could only be brought from the islands under the supervision of a Government agent, who was to be present at the islands and see the contract entered into; so that, unless it was supposed that these gentlemen were, as a body, corrupt, and connived at piracy and kidnapping, it could not be imagined that any wrongdoing was practised. The islander was shipped under the supervision of the Government agent; he was brought to Queensland in the same ship with the Government agent, and on arrival, a police magistrate, a gentleman high in the public service of the colony, went on board as protector of the coloured labourer, to see that he understood the nature of the contract, and if he did not, no contract could be made, and he was free. If he accepted it, then during his stay in Queensland every protection was afforded him;

visitations of the plantations were regularly made by a public officer, to ascertain that the treatment of the islanders was strictly according to law. He knew many of these planters, but he had no interest in any plantation, and never had, and had never given an hour's employment to any of these people; he spoke simply as a representative public man, who was in England not to take part in any public discussion, but merely on a year's leave, after spending 28 years in the colony. With regard to the Chinese, the Queenslanders, like many others, had a strong objection to their presence. Some few looked on their presence with equanimity, and even with approval, but the great majority did not. He had travelled home by way of Sydney, New Zealand, Honolulu, San Francisco, and the Northern States, and everywhere he found that the Chinaman's presence was disagreeable. There was one principle underlying the policy of all Queensland statesmanship, and that was that Queensland should be a white man's land; they wished it to be the home of English-speaking people and of European blood, and there was a very strong objection, on the part of a large number of the colonists, to the presence even of Polynesians; so that, even from that point of view, there was a strong and vigilant party who would immediately raise an outcry against any abuses. To that party belonged most of those with whom he was accustomed to act when he was a politician. But even the opponents of that great party would agree that, if white men were able to stand the hard work and the heat, they would much prefer having them to deal with; such were more intelligent, capable of more sustained labour, and in every way better fitted, if they could stand the heat and the labour amongst the canes. That was the moot point, and he believed that those who objected to coloured labour, if they were assured that white men could not perform the labour of the fields, would not object to coloured labour within certain well-defined limits. Those limits had been prescribed by statute, such employment being restricted to within thirty miles from the coast; firstly, for the protection of the labourers; and, secondly, that they should be confined to the actual cultivation for which they had been imported. He hoped he had now satisfied the meeting that everything was done which could be done by a people who, like the English, hated slavery, and everything which savoured of it. With regard to the aborigines, in some of the extreme northern parts of the country tribes of black men were still to be found; but, in general, the blacks were quite harmless towards the settlers. Sometimes they attacked cattle and sheep, but, in general, a traveller might pass quite as safely from one end of Queensland to the other, alone, as he could in England. His son, a lad of 18, a month or two before he left, went from Brisbane right up to the Gulf of Carpentaria with a party of men, horses, and cattle, and returned alone. In fact life was quite as safe in Queensland as in England, and much safer than it was in Ireland.

Mr. FREDERICK YOUNG, after complimenting Mr. Stanesby on his paper, said he had been much pleased with the account which he gave of the land laws of Queensland and the other Australian colonies—a subject on which information was much required. Queensland had had the opportunity of profiting by the experience of other colonies in this respect, and seemed to have taken advantage of it. What had been said by subsequent speakers was quite sufficient to show that abundant care was taken to protect the Polynesians, and he was glad to see the line taken with regard to New Guinea. That was a question in which the Royal Colonial Institute, which he represented, had taken a great interest for some years, and on the ground which had been so well put forward that evening. They had taken it up entirely from an Imperial point of view, and had certainly nothing to do with promoting the interests of planters in getting black labour. Their view was that, if New Guinea were not taken possession of by this country, it might fall into the hands of some foreign power; which would be very detrimental to the interests of the Australian colonies, and seriously interfere with the trade which was growing up with India and China.

Mr. STANESBY, in reply, said some people stated that, notwithstanding all the advantages of a colonial life, they preferred a home life, on account of its hallowed associations and old traditions, and that they could not feel the same patriotism in a new country. Now, if Queenslanders had not this feeling of patriotism, they certainly had a good substitute for it in a strong *esprit de corps*, as was shown by the meeting that evening. There was the Chief Justice of the Colony out for a holiday, and only just arrived in England, and yet he took the trouble to come to the meeting, and speak up for the colony which he loved. And though he himself was not aware that Sir Charles was coming, he was not at all surprised at it, for he knew what a pride Queenslanders took in their colony, and that when they came home they could not help talking about it.

The CHAIRMAN, in proposing a vote of thanks to Mr. Stanesby, said he had known his family for many years, and he was glad to see that the good education he had received in the old country had not been thrown away. When he went to the other side of the globe, after the experience of a good many years he came back as good an Englishman as he went and a better Australian. He hoped the suggestion which had been made would not be thrown away on society in England at the present moment. Every day it was more difficult for young men to suit themselves with an occupation which provided for present needs, and opened the way for advancement; and we should not be the legitimate heirs of the great heritage of which we sometimes talked, if we lost sight of the advantage which we possessed in being the centre state of a great and growing empire

It was from an imperial point of view that men like Mr. Young, Mr. Archer, and himself had long endeavoured, as opportunity offered, to awaken public feeling to the great duty of drawing closer the ties, not merely of relationship, but of friendship, sympathy, and fellow patriotism with our daughter communities all over the world. He did not believe that England would, in the long run, be able to hold her own with the competitive ambitions of the world, if she threw away her advantages in this respect; but, with those advantages, with an ever expanding trade, with an annually improving scientific effort, and, above all, with a true Christian patriotic spirit, we need fear no rivals. Every young man who came back, and showed what could be done with a little bold venture in the prime of life, did great good, and helped to correct that prevalent ignorance and apathy which was always the fault of an old country. He could not sit down without also thanking Sir Charles Lilley, who had come with the weight of his experience, and given most valuable information. As a member of the House of Commons, he felt exceedingly grateful to him for having, in a short space, corrected some misapprehensions of his own, and dissipated many doubts by which, in common with many others, he had been troubled. It was a grand thing that a man of the profession to which he himself had the honour to belong, should early in life go to a colony, rise to supreme judicial authority, and come home, to say that he had not ceased to be an Englishman, and that he could, with the freedom which every educated Englishman, or, at all events, every judge, was distinguished for, defend manfully, when his robes were off, the country to which he belonged. The seed sown that evening he was sure would not be lost, but would germinate and grow, and he had no doubt that some now present would live to see the fruits.

The vote of thanks was carried unanimously, and the proceedings terminated.

Miscellaneous.

TASAR SILK.

A report from Major G. Coussmaker, superintendent of the Government Photozincographic-office, to the Secretary to the Government, General Department, on tasar sericiculture in the Bombay Presidency, dated Poona, 14th February, 1883, has been communicated to the Society of Arts by the Secretary of State for India. This is the last report which Major Coussmaker will make on the subject, and he does not recommend Government to continue these experiments, as there seems to be very little prospect of their proving remunerative, owing to three causes:—(1) A very large supply of wild silk is now exported from China, and the price of "tasar waste" has, in consequence, fallen to 1s. 3d. per lb. in England; (2) the tasar cocoons of the Bombay Presidency are smaller and contain less silk than those found in other parts of India; (3) the expense of collecting the cocoons, or of rearing the worms in a state of semi-domestication, as he had done, is great. Major Coussmaker proceeds:—

In paragraph 4 of my No. 2 of February 3rd, 1882, I mentioned that I had sent home to Mr. Wardle the collections which I had made in two years. He sold these cocoons, weighing altogether 197 lbs., to Messrs. Clayton, Marsden and Co. of Halifax, at 1s. 3d. per lb., and sent me the money, which amounted to Rs. 146-14-0. The spinners report that "the fibre from these cocoons is somewhat coarser than most tasar waste, and the cocoons have been opened; but this is not a serious drawback to its spinning qualities. China is now sending over such large quantities that the price of tasar waste is very low." I do not think that the cocoons can be collected from the forests at a cheaper rate than four annas per hundred, and this is too high to admit of any profit. The collections made have fallen off considerably, and it is only through the personal exertions of the officers and guards of the Forest Department that I have received as many as I have. I found the same thing myself when I was out in the districts. In whatever village I was encamped, I could get the children to collect for me, but the price was not high enough to induce men to leave their work and look for cocoons. The village trader took no interest at all in the matter. I have tried, nearly every year, to increase the size of the cocoon, by importing some of the large variety from Sambalpur, Yamtasa, Manbhoom, &c., but with no success. The moths have paired readily with the small Deccan variety, the worms have hatched out, but there has been no difference in the cocoons, and I believe that the climate is the unsurmountable obstacle, though, perhaps, the difference of food may be another cause. As far as quantity is concerned, the result of rearing the tasar silk-worm in semi-domestication is most satisfactory. I have now been able to gather, within six weeks, three cocoons per running foot of hedge. My first worm, this last season, was hatched on 9th May, and the first cocoon was gathered in 32 days time. Of this particular batch of worms, I took careful notes; they numbered 380, and 347 of them spun cocoons, commencing on 7th June and ending on the 24th June. They consumed 110 running feet of hedge, a few feet of which consisted of cuttings that had been kept growing for a twelvemonth; but the greater part of their existence was spent on a lagerstrœmia hedge, which, on the 1st May had been cut down to 2 feet in height, cleared of every twig and vestige of a leaf, irrigated every third day, and enclosed within tarred screens of split bamboo, over which a coarse cotton covering had been stretched on rattan hoops; as fast as this hedge was eaten off, it sprouted again, and by the

time the worms had reached the far end, the new shoots on the first tree were covered with leaves. Of the 1,800 feet of lagerstrœmia and zizyphus which I have now got, one half was sufficiently grown to yield a steady supply of food, and of this extent of hedges I gathered in May to October 5,678 cocoons; but, as in former years, I noticed that only 50 per cent. of these were sound and perfectly formed, and these were almost all gathered before the end of July. Later in the season I lost, without any apparent cause, many hundreds of worms in all stages; some being the progeny of moths of the former year, and some of this under review. Still there were many cocoons spun, some of which were very fine, but the majority were weak and thin. My method of protecting the worms and ensuring a steady supply of food is most effective. The labour bill is reduced to a minimum; one woman and one boy can easily look after an acre of hedge, if not more, and keep the enclosures in repair; but it must be borne in mind that if the monsoon does not break early and heavy, it will be necessary to water the hedges, and also the expense of enclosing is so very heavy, that, as long as the price of tasar keeps low, this system cannot with profit be followed. In the neighbourhood of dwellings, crows, sparrows, squirrels, and rats will collect, and must be kept out; this I succeeded in doing with material always available in India, but it is an expensive process. I used bamboo, buying it and making it up into chicks or screens, at Rs. 2 per 100 square feet; rattans, of which 10½ feet weigh 1 lb., at Rs. 3 per 1 lb.; coarse cotton cloth at Rs. 2-2 per 11 running yards; iron rods, 2 inches in circumference, at Rs. 4 per 100 feet; common country string and tar; but at these rates the enclosing of an acre of hedge costs an initial outlay of Rs. 3,915-12, with a yearly expenditure of Rs. 305, to keep it in repair, and at the present price of tasar waste only Rs. 23 can be expected from the 20,205 cocoons which an acre of hedge would yield. I am here calculating for the one good crop which would only be on the ground, or rather on the hedge, between 1st May and 31st July; but the land would for nine months of the year be available for other crops. Perhaps some other experimentalist will be able to hit upon a cheaper method of enclosing.

I have only attempted the collection of tasar waste; it is most probable that the production of perfect dry cocoons ready for the reeler, or reeled raw silk, may be more remunerative; but the first problem I set myself was "how to secure a steady supply," and until I had solved that I had determined not to attempt anything more. Ten years ago, Messrs. Lister and Co., of Bradford, in a letter to me on the subject, wrote—"It will pay you best to let all the moths fly, and sell the burst cocoons." I think that it is apparent, from what I have mentioned already in this report, that the production of burst cocoons, *i.e.*, tasar waste, will not pay.

It is well known that the great objection to this silk was its natural colour and reputed inability to take dye satisfactorily. Mr. Wardle has made a persistent series of experiments to overcome these defects, and informs me that he has now perfectly succeeded, and there will always be a demand for clean, evenly reeled tasar silk thus bleached.

Major Coussmaker, concludes his report thus—I have now wound up my series of experiments, having year by year reported on what I have learnt, and can only regret that the conclusion is so very adverse to the prospect of the tasar silk industry in this Presidency.

THE RUSSIAN SECTION OF THE INTERNATIONAL FISHERIES EXHIBITION.

Some idea of the importance of the fishing industry in Russia may be formed from the fact, that the quantity of fish caught annually in the European portion of the Empire amounts to 645,000 tons, including 700,000,000 head of roach, and that 3,225 tons of sturgeon caviare are produced yearly. Although rather behind hand in opening, the Russian section is one of the most complete in the Exhibition. The corrugated iron building is decorated with the Russian marine and commercial flags, while the arms of the twelve provinces, all composed of fish or some kind of aquatic animals, alternate with analytical tables, prepared by Professor Kostytchef, showing the nutritive value of the various species caught in Russian waters, aud others by Professor Schmidt, of the sea, lake, and river water of the Empire There is an important official collection of the principal commercial fish, both stuffed and preserved. This includes the Schemaya *(Alburnus chalcoides)*, found on the shores of the Caspian sea, somewhat resembling a large pilchard, very rich in oil, and also a fish which is between the sturgeon and the sterlet, being more agreeable to the palate than the former, and possessing a higher nutritive value than the latter.

A model of the Vrassky piscicultural establishment, which is correct in its general arrangement, though the details are not quite complete, is exhibited; the inventor is known as the founder of the Russian system of fecundation. Wax models, illustrating the development of the sterlet, are contributed by Professor Ovsiannikof, and of that of various *salmonidæ* by Pelzam, of Kasan, while the Government send models of the tanks used in transporting the fry. There is also a collection of the works of Prof. Girdvoyn, of Warsaw, well known in Europe for his investigations into the parasitic diseases affecting the salmon tribe, together with plans illustrative of various methods of pisciculture. Besides the caviare of the sturgeon, that of the coregone, a fish bearing some analogy to the *Fera* of Switzerland, is exhibited.

The various methods by which fish are caught in different parts of Russia are fully illustrated. Netting and cordage are prominent objects, some of the best cordage in the whole collection being shown by the Hoth establishment of St. Petersburg. The nets ex

hibited are remarkably fine and strong; in one specimen, the floats consist of gourds, and in another of pieces of birch-bark rolled up spirally. Most varieties of fish, freshwater as well as sea, are preserved by slightly salting, and a subsequent drying in the sun, or smoking. The dried specimens are exhibited, and also the model contributed by Sapojnikoff, of an establishment where the curing process is conducted.

An interesting object is the model of a floating fishmonger's shop, such as is common on the Neva and the canals of St. Petersburg. Some of the fish is frozen, being kept in boxes of ice or snow, according to the season, and others are dried; while floating tanks, with several compartments, afford a choice of various fresh fish. As might be expected, some fine specimens of isinglass are shown, as also are the dorsal tendons of the sturgeon, which, having all the appearance of isinglass, form an important food substance. A product, comparatively new to commerce, is shown in some lamprey oil of a fine orange colour; although the lamprey itself is eaten either salted or pickled, the oil only serves for illumination and lubrication.

Some remarkably close barrels for the transport of fish are sent by Mesner and Sapojnikoff, of Astrakan; they are made from oak, plane, and other woods, by a mechanical process which gives better results than hand-work. The fur of the *phoca*, walrus, and white bear are shown, as well as those animals stuffed and effectively set-up. Russia does not yet figure in the official catalogue; but a special notice of the section is being prepared by Dr. Grimm, under the superintendence of Commissioner-General Nicholas Solsky, and the Assistant Commissioner, Baron Paul Tcherkassoff. The inspector of the Russian Section is Engineer Charles Schoeneich, who is constantly in to give explanations to visitors.

COCOA-NUT FIBRE.

Within the last twenty years a vast extension of the economic uses to which this valuable fibre is put has taken place. The term "coir," usually applied to this material, is the Anglicised form of the South Indian "kayaru," cord or twine, and is not applied in India to the raw fibre, which is called in the Tamil language "savuri." The fibrous husk or rind of the cocoa-nut is easily stripped from the nut while yet green, by striking it on the point of an iron spike, and then is steeped in salt or brackish water, where it lies for several months, until the softer portions of the husk rot away, and the strong fibre alone remains. This is taken out, beaten with a stick to separate and clean the fibre, and twisted with the required number of strands into rope, or woven into matting, while the stiffer fibres are made into brushes and other articles of domestic utility. The fibre is pressed for shipping into bales weighing 200 lbs. each. The attempt has been made to prepare the fibre from the dried husk in England, but without success.

Much of the coir fibre used in England is brought from Ceylon; but a large and increasing quantity is now exported from Bombay and the Western Coast of India. The supply is not inexhaustible; but as prices rise, cultivation is encouraged, and as the growth of this palm is along the sea coast, where other crops cannot be grown, the trade is a profitable one.

Factories for the weaving of coir matting have been opened by English and American firms at Allepy, Quilon, Colachel, Cochin, &c., and turn out a considerable quantity of goods. Spinning is not attempted here, being more cheaply done by hand at the places where the fibre is produced. Along the coasts of the backwaters and canals many people may now be busily engaged in scraping and cleaning the fibre and twisting it into yarn. In the factories the yarn is first sorted to its various shades and qualities. The warp is made by boys running backwards and forwards, then it is flattened and smoothed for weaving, by being run through heavy rollers. The weaving is laborious work, performed by men, who earn two or three rupees a week at it. The web is again rolled to give it some finish, wound securely in a roll, and marked.

Large profits have been made in this manufacture in India. But it can now be carried on so much better in England, with the machinery and appliances available here, that large quantities of the yarn are exported. One firm in Lancashire have introduced steam loom weaving of this material. The various shades of fibre—cream-coloured, reddish brown, and blackish—which vary greatly according to care and skill in preparation, are first carefully separated, and cocoa-nut matting is now made of fine quality, with pretty shades of colour and in pleasing patterns, so as to be available for higher uses than the very coarse makes, and the material is most durable. The yarn is also plaited by machinery into cinnet or belting.

Cables made of coir bear exposure to salt water better than anything else, the tannin which it contains preventing the fibre from rotting; they are exceedingly light and buoyant, as well as elastic. Coir cordage, in Dr. Wight's experiments, broke at 224 lbs. weight. Even the refuse and broken fibre can be turned to account for stuffing mattresses, and is used in horticulture, &c., as no insect will touch it.

The exports from Travancore of this material form a large proportion of the trade of the district, and amounted, in 1879-80, to nearly 150,000 cwt., valued at 13¾ lacs of rupees (say £137,290), and paying to the Government a duty of 68,000 rupees. Of the cocoa-nuts themselves, nearly 9,000,000, valued at nearly 260,900 rupees, and paying customs duty, 13,000 rupees, were sent away. Other products of this palm exported, as oil and copra or dried kernel, were valued, the former at 322,100 rupees, and the latter at no less than 26½ lacs of rupees, making a total value of the export of products of the cocoa-nut palm, from Travancore alone, of 46¼ lacs of

rupees (nearly half a million sterling). Some thousands of tons are also exported from Cochin.

Cocoa-nut fibre is so durable, useful, and economical a material that a great future is assured for the industry; and, as prices rise, the natives will pay increasing attention to the collection of the whole amount produced, and to its careful preparation. Perhaps when, through increasing demand, the fibre becomes still more expensive, it may be found possible to prepare it of greatly improved quality and appearance by steaming or boiling, so as to avoid the pollution of ponds and backwaters by the decomposing pulp of the husk, and the consequent blackening of the fibre so often observed. The textile ingenuity of the present age of invention may perhaps devise some additional uses for this fibre; hats and bonnets made of this material have, it is said, attracted much attention.—*The Colonies and India.*

RUSSIAN TRADE WITH ASIA.

Some particulars relating to Russian trade with Northern and Central Asia, taken from the *St. Petersburg Herald*, have been printed lately in the *Manchester Guardian*. Russia appears to have set herself the task of opening up these regions to European culture and trade, mainly with a view to the development of her own industry and commerce. The annual fair at Nijni Novgorod may be taken as a fair measure of Russian trade with the East. Seven great trade routes centre in this town, and along these Persia, Armenia, the Caucasus, Trans-Caucasia, Bokhara, Khiva, and other Central Asian regions, Eastern and Northern Russia, Siberia, and even China send their produce for exchange against European and non-European goods. In 1879 the amount of the goods received at the fair was 180,644,200 roubles; in 1880, 200,446,278 roubles: in 1881, 246,180,238 roubles; last year it declined to 223,502,978 roubles. The decrease was due to the lowness of the rivers, which caused a block in the traffic. The goods chiefly traded in at the fair are classified in four groups: (1) Russian goods, including wool and woollen fabrics, cotton tissues, linen and hemp manufactures, silk and partially silk articles, fur and leather goods, glass, stoneware, earthenware, metals and metal manufactures (especially iron), cereals, salt, liquors, fish, oil, petroleum, soap, tobacco and tobacco manufactures, writing materials, ornamental goods, clocks and watches, musical instruments, and apparel; (2) foreign, European, and colonial goods; (3) drugs, dyes, and apothecary's wares, including indigo and cochineal, of which considerable quantities are sent to Persia; and (4) Chinese goods, including tea as a very prominent article, an enormous quantity of this commodity being sold. Raw cotton, cotton yarns and tissues, felt, furs, madder, and silk are received from Bokhara and China. Persia sends cotton and silk, precious stones, carpets, Cashmere shawls, gallnuts, and spices. The Russian goods are equivalent to three-fourths of the total quantity handled, and of these three-fifths are textile goods. Last year the Russian goods alone were valued at 185,000,000 roubles, cotton goods (the supply of which was smaller than usual), representing 46,000,000 roubles in this amount, silk and partially silk yarns and tissues 12,000,000 roubles, linen and hemp goods 4,500,000 roubles, and metals and metal manufactures 20,000,000 roubles. When it is remembered that Russia holds fairs of the same character at several other centres, some of which (as, for instance, that at Irbit, in the province of Perm, with the annual turnover of about 40,000,000 roubles, and those at Poltava, Kursk, and Verditschew) are very large, the considerable volume of this branch of Russian trade, in which trade with Asia is an important element, will be realised. The growing proportion of the business in Russian goods at these fairs testifies to the development of Russian industry, and explains the jealousy of foreign manufactures which influences the Russian customs policy. Russia bases her hopes of commercial industrial prosperity to a very large extent upon Central Asian trade.

FISHERY CONGRESS.

In addition to the notice in last week's *Journal* of the conferences to be held at the International Fisheries Exhibition, may now be added the following list of subjects for conferences, which have been settled; the authors, whose names are given, have consented to read papers:—"British Fisheries and Fishermen," H.R.H. The Duke of Edinburgh; "The Fisheries of the United States," Professor Brown Goode; "The Fisheries of the Dominion;" "The Fisheries of other Countries;" Commissioners from Sweden, Norway, Netherlands, China, &c., have promised to take part in the conferences; "Herring Fisheries," Mr. R. W. Duff, M.P.; "Pilchard and Mackerel Fisheries," Mr. T. Cornish; "Salmon and Salmon Fisheries;" "Fresh Water Fisheries (including Trout), Mr. Francis Francis; "Seal Fisheries," Captain Temple; "Oyster Culture and Fisheries," Professor Hubrecht; "Molluscs, Mussels, Whelks, &c., used for Food or Bait," Mr. Charles Harding; "Line Fishing," Mr C. M. Murdahl; "Trawling;" "The Application of Steam-power to the Fishing Industry;" Principles of Fishery Legislation," Rt. Hon. G. Shaw Lefevre M.P.; "Fish Culture and Acclimatisation of Fishes," Sir James Maitland; "Fish as Food," Sir Henry Thompson; "Fish Transport and Fish Markets," His Excellency Spencer Walpole; "Food of Fishes," Dr. F. Day; "Storm Warnings," Mr. R. H. Scott; "Fish Diseases," Professor Huxley; "Economic Condition of Fishermen," Professor Leone Levi; "Protection of Life of Fishermen;" "Scientific Results of the Exhibition," Professor Ray Lankester

Correspondence.

PREVENTION OF FIRES IN THEATRES.

During the discussion on the Report of the Committee, Mr. Cornelius Walford made practical mention "of theatres being in open spaces, constructed like the Albert-hall, with an outer shell, and an inner shell; when a fire took place in the inner shell, the people had no difficulty in removing rapidly to the outer shell, or the passage between the two, and in that way they were safe."

It seems a pity that a few more of our architects have not visited the grand old Roman ampitheatres of Arles, Orange, and Nimes, where the above plan was carried out nearly 2,000 years ago. At Nimes, the corridor surrounding the building is roofed with stone slabs, 18 feet long, with wedge-shaped passages (cunei), radiating from the centre, and widening outwards, like a funnel, to facilitate the egress of the crowds. This building must have held some 20,000 persons. If I recollect rightly, there were twenty-six stone staircases or vomitories.

Of course, we cannot expect that every manager can construct one of these vast piles; but, surely the Legislature may compel him to build with some regard for human safety, and prevent traps and warrens being multiplied in hole and corner places.

Mr. Dixon-Hartland, M.P., considered the average length of the life of a theatre was under 23 years. The ampitheatre at Nimes was converted into a fortress by the Visigoths; the Saracens occupied it as such in the 8th century; and Charles Martel endeavoured to destroy it by fire, by filling its vaults and passages with wood and setting fire to it.

HENRY MITCHELL.

39, Meckleburgh-square, W.C.,
9th June, 1883.

Notes on Books.

A RUDIMENTARY TREATISE ON CLOCKS, WATCHES, AND BELLS. By Sir Edmund Beckett, Bart. Seventh edition. London: Crosby Lockwood and Co. 1883.

This is practically a ninth edition of Sir Edmund Beckett's work on clocks and watches, for the articles written by the author as the eighth and ninth editions of the *Encyclopædia Britannica* were abridgments of this book. The portion devoted to clocks is practical, and intended to help those who wish to make, or direct the making of their own clocks of superior character; but as an amateur is not likely to make a watch, the part on watchmaking deals more with principles than with working details. A list of the great bells of Europe, with date, diameter, and weight, is given at the end of the book.

PLUMBING: a Text-book to the Practice of the Art or Craft of the Plumber, with supplementary chapters upon House Drainage. By William Paton Buchan. Fourth edition. London: Crosby Lockwood and Co. 1883.

The text-book for the practical plumber under notice has grown out of a series of articles in the *Building News*, which were written in 1871. These articles had grown into a book in 1876, a second edition of which appeared in 1879, and now a fourth edition has been issued. The different forms of sanitary appliances are fully illustrated, and special attention has been paid in this edition to the subject of ventilation.

NOTES ON THE PRINCIPAL PICTURES IN THE LOUVRE GALLERY AT PARIS. By Charles L. Eastlake. London: Longmans and Co. 1883.

NOTES ON THE PRINCIPAL PICTURES IN THE BRERA GALLERY AT MILAN. By Charles L. Eastlake. London: Longmans and Co. 1883.

Mr. Eastlake has selected for description the finest and most remarkable pictures in the Louvre, some of which are further illustrated by small sketches. The official catalogue occupies more than 1,200 pages, and the object of the author of these notes is to supply the visitor whose time is limited with a more handy book. He criticises the various pictures, and refers to the catalogue when that work contains special information which the student should see. The notes to the Milan gallery form a similar volume; and guides on the same plan for the Munich Pinakothek and the Venice gallery are in course of preparation.

EDUCATION. By J. Maclochlin, late one of H.M. Inspectors of Education. London: Elliott Stock. 1883.

The author deals with his subject as a whole, and treats, as stated on the half-title, of "Education, Instruction, and Self-culture." The first part is devoted to the scope, the aim, and object of education, the second part to suggestions for the improvement of the character of popular instruction; and, under this division, extended university education, middle class or superior primary schools, and elementary schools, and technical or handicraft instruction are specially referred to. The third part is on self-culture.

General Notes.

NEW YORK UNDERGROUND RAILWAY.—A Bill for an underground railway in New York has already passed the House of Representatives, and, no difficulty being anticipated with the Senate, it is expected that the work of construction will begin at once. The proposal is to run an arcade road under Broadway, from near Bowling Green, right through to Harlem River. The capital is said to be all subscribed, though no list of the shareholders has been issued. The new venture will be a formidable competitor of the elevated roads, and its projectors claim that it will not only be safer, but that it will be able to maintain a much higher rate of speed, and to carry passengers for less than 10 cents each.

NICE INTERNATIONAL EXHIBITION.—An International Exhibition is announced to open at Nice, on 1st December, 1883. The following resolutions and regulations have been passed by the executive committee, peesided over by the Mayor :— 1. The latest time for receiving exhibits, previously fixed for 15th October, is now extended to 1st November. 2. Applications for space must reach the Commissariat-Général of the Exhibition before 15th July, in the case of French exhibitors, before 15th August for English and European exhibitors, and before 15th September for those in the French colonies and other countries. 3. A section of anthropology and pre-historic archeology, organised with the co-operation of the Paris Anthropological Society, will be annexed to the Exhibition. 4. An international competition in vocal and instrumental music, the date, with particulars, to be fixed subsequently, will be held during the Exhibition. 5. The Central Exhibition building will be enlarged so as to accommodate all exhibits, on account of the numerous applications for space which have been received. It is also stated that the French railway and steamboat companies, and several foreign companies, have made a reduction of 50 per cent. on their rates in favour of goods for exhibition. For further particulars, address M. A. Borriglione, Deputé et Maire de Nice, France.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 18...Asiatic, 22, Albemarle-street, W., 3 p.m.

TUESDAY, JUNE 19...Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m.

Statistical, Royal School of Mines, 28, Jermyn-street, S.W., 7¾ p.m. Mr. Stephen Bourne, "Food Production and its International Distribution."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Dr. J. Gwyn Jeffreys, "The Mollusca procured during the Cruise of H.M.S. *Triton* between the Hebrides and Faröes in 1882." 2. Prof. P. Martin Duncan, "The Madreporarian Genus *Phymastræa* of Milne-Edwards and Jules Haime, with a Description of a New Species." 3. Mr. Martin Jacoby, "Description of some New Species of *Galerucidæ*." 4. Dr. J. S. Garson, "The Anatomy of *Porcula salvania*."

WEDNESDAY, JUNE 20...Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Rev. W. Clement Ley, "The Structure of the Ice-Cloud disposed in threads proposed to be called 'Cirro-filum.'" 2. Mr. Richard H. Curtis, "Notes on a Second Series of Experiments on the Distribution of Pressure upon Flat Surfaces Perpendicularly Exposed to the Wind." 3. Hon. Ralph Abercromby, "The Reduction of Wind Records." 4. Mr. Frederic W. Cory, "The Spectroscope as an Aid to Forecasting Weather." 5. Mr. Robert H. Scott, "Note on River Temperatures as compared with Air Temperatures at Greenwich and Bremen." 6. Mr. Robert Lawson, "The Influence of the Moon on the Height of the Barometer within the Tropics."

Geological, Burlington-house, W., 8 p.m. 1. Mr. A. J. Jukes-Browne, "The Relative Ages of certain River-valleys in Lincolnshire." 2. Mr. H. J. Johnston-Lavis, "The Geology of Monte Somma and Vesuvius, being a Study in Vulcanology." 3. Prof. W. Boyd Dawkins, "The Discovery of *Ovibos moschatus* in the Forest-bed, and its Range in Space and Time." 4. The late Mr. E. B. Tawney and Mr. H. Keeping, "The Section at Hordwell Cliffs from the top of the Lower Headon to the base of the Upper Bagshot Sands." 5. Mr. R. F. Tomes, "Some New or Imperfectly known Madreporaria from the Coral Rag and Portland Oolite of the Counties of Wilts, Oxford, Cambridge, and York." 6. Mr. John Young, "Note on 'Cone-in-Cone' Structure." 7. Mr. Alfred Morris, "A Geological Sketch of Quidong, Manaro, New South Wales."

THURSDAY, JUNE 21...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Professor P. M. Duncan, "Structure: Hard Parts of Fungidæ II." 2. Mr. R. A. Rolfe, "The Selagineæ, described by Linnæus and others." 3. Rev. R. Boog Watson, "Mollusca of the *Challenger* Expedition, XX.".

Chemical, Burlington-house, W., 8 p.m. 1. Ballot for the Election of Fellows. 2. Professor H. McLeod, "Evaporation in Vacuo." 3. "Note on Hydrocarbons from Camphor." 4. Prof. H. E. Armstrong, "Note on some Substitution Derivatives of Camphor." Mr. H. Veley, "The Decompositon of Ammonium Nitrate, an Investigation into the Rate of Chemical Change."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. W. A. Stanley, "The Drama."

Royal Historical, 22, Albemarle-street, W., 8 p.m.

Numismatic, 4, St. Martin's-place, W., 7 p.m. Annual Meeting.

Royal Society Club, Willis's-rooms, St. James's, S.W., 6½ p.m. Annual Meeting.

FRIDAY, JUNE 22...Royal United Service Institute, Whitehall-yard, S.W., 3 p.m. Surgeon-Major F. S. de Chaumont, "Military Hygiene."

Quekett Microscopical Club, University College, W.C., 8 p.m.

SATURDAY, JUNE 23...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Prof. D. E. Hughes, "Researches on the Cause of Evident Magnetism and Neutrality in Iron and Steel." Illustrated by Experiments. 2. Prof. G. W. Minchin, "A Sine Electrometer." 3. Mr. George Kamensky, "The Induction, Balance, Effect, and Densities of Alloys of Copper and Antimony."

Royal Botanic, Inner Circle, Regent's-park, N.W. 3¾ p.m.

Journal of the Society of Arts.

No. 1,596. Vol. XXXII.

FRIDAY, JUNE 22, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Twenty-ninth Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurer's statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new Members, will be held, in accordance with the Bye-laws, on Wednesday, the 27th of June, at 4 p.m.

(By order of the Council)

H. Trueman Wood,
Secretary.

CONVERSAZIONE.

Sir William Siemens, the Chairman of the Council, and the Council will receive the members of the Society at a Conversazione, to be held (by kind permission of the Executive Committee) in the buildings of the International Fisheries Exhibition, South Kensington, on Wednesday, the 11th July next.

Their Royal Highnesses the Prince and Princess of Wales have intimated their intention to be present.

The invitations will be for half-past seven. It is hoped that the members and their friends will arrive early, and will distribute themselves about the buildings, so as to prevent local crowding, especially near the entrance.

The Exhibition Buildings and the gardens will be open, and lighted by the electric light.

Cards of invitation will shortly be issued to the members of the Society. Each member will, as usual, receive a card for himself and one lady.

Further details as to the arrangement will be announced hereafter.

ALBERT MEDAL.

The Council of the Society of Arts have (with the approval of H.R.H. the Prince of Wales) awarded the Albert Medal of the Society for the present year to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and as Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of the several colonies and dependencies of the Empire."

SWINEY PRIZE.

The Council have to give notice that the next award of this prize will be in January next. Dr. Swiney died in 1844, and in his will he left the sum of £5,000 Consols to the Society of Arts for the purpose of presenting a prize, every fifth anniversary of the testator's death, to the author of the best published work on Jurisprudence. The prize is a cup value £100, and money to the same amount; the award is made jointly by the Society of Arts and the College of Physicians. The cup now given is made after a design specially prepared in 1849 for the first award, by D. Maclise, R.A. Any person desiring to submit a work in competition, or to recommend any work for the consideration of the judges, should do so by letter addressed to the Secretary of the Society.

PRACTICAL EXAMINATIONS IN MUSIC, 1883.

It has been determined not to publish any list of the successful candidates at the above examinations, as announced in the programme, it having been found that such a list would not be representative, on account of the large number of candidates who wish their names should not appear.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with sec. 40 of the Society's Bye-laws:—

TREASURERS' STATEMENT OF RECEIPTS, PAYMENTS, AND EXPENDITURE FOR THE YEAR ENDING MAY 31ST, 1883.

Dr.

	£ s. d.	£ s. d.
To Cash in hands of Messrs. Coutts and Co., 31st May, 1882	1,183 13 11	
Do. in hands of Secretary	11 8 7	
		1,195 7 6
,, Subscriptions received during the year from Members and Institutions in Union	6,128 7 0	
,, Life Compositions	672 0 0	
		6,800 7 0
,, Dividends and Interest		633 0 11
,, Ground Rents		87 0 0
,, Sale of £4,500 Consols (Swiney Bequest) for re-investment		4,477 10 0
,, Bequest from the late Christopher Cooke, Esq.		10 0 0
,, Examination Fees		299 18 11
,, House and Office, (receipts for gas, &c.)		87 8 2
,, Advertisements		1,264 11 6
,, Donations towards Gas Engine and Dynamo Machine		145 15 0
,, Plant Label Prize, given by G. F. Wilson, Esq., F.R.S.,		5 5 0
,, Sales—		
Cantor Lectures	15 0 6	
Journal	142 13 0	
Patent Bill	5 6	
Public Health Conference Reports	1 19 1	
Spoiled Post-cards	2 2 11	
Transactions	3 6 0	
		165 7 0
		£15,171 11 0

Cr.

	£ s. d.	£ s. d.
By House and Premises: -		
Rent, Rates, and Taxes	339 19 4	
Insurance, Gas, Coal, House expenses, and expenses incidental to ordinary meetings	310 14 3	
Repairs and Alterations, including Electric Lighting	2,404 3 2	
		3,054 16 9
,, Office:—		
Salaries and Wages	1,934 9 0	
Stationery, Office Printing, and Lithography	292 8 4	
Advertising	68 10 1	
Postage Stamps, Messengers' Fares, and Parcels	182 14 9	
		2,478 2 2
,, Library, Bookbinding, &c.		88 14 4
,, Conversazione		288 3 4
,, *Journal*, including Printing, Stamps, and Distribution		2,294 5 11
,, Advertisements (Agents and Printing)		532 17 5
,, Examinations		425 7 11
,, Proposed Memorial of 1851 Exhibition		32 6 0
,, Medals:—		
Albert (1882)	23 12 8	
Society's	24 15 0	
Sanitary Prizes	6 15 0	
		55 2 8
,, Owen Jones Prizes		5 11 0
,, Cantor Lectures		227 8 1
,, Juvenile Lectures		24 8 0
,, Sections:—		
Applied Chemistry and Physics	75 19 6	
Foreign and Colonial	61 0 0	
Indian	50 16 0	
		187 15 6
,, Committees:—		
Education Code	7 7 3	
Fires in Theatres	14 3	
Patent Bill	29 8 10	
Plant Labels	8 0 8	
Poisonous Colours	4 12 7	
General expenses	15 0 9	
		65 4 4
,, Exhibitions:—		
Photographic	6 4 5	
Pottery	27 18 11	
		34 3 4
,, Annuity to Mrs. Cantor	25 0 0	
,, ,, Mrs. Le Neve Foster	100 0 0	
		125 0 0
,, Investment of proceeds of Sale of Consols representing Swiney Bequest (together with a balance of £123, Society's Funds), in the purchase of Ground Rents, including costs of transfer		4,794 13 9
		£14,714 0 6
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1883 £460 16 11		
Less by cheque uncashed 20 0 0		
	440 16 11	
,, Ditto in hands of Secretary	16 13 7	
		457 10 6
		£15,171 11 0

Liabilities.

	£ s. d.	£ s. d.
To Tradesmen's Bills	390 11 2	
,, Rates	47 18 4	
,, Examiners' Fees	128 11 6	
,, Sir Walter Trevelyan's Prize	100 0 0	
,, Sections:—Foreign and Colonial, Applied Chemistry, and Indian	170 0 0	
,, Prizes offered, and accumulations under Trusts	585 15 6	
		1,422 16 6
Excess of Assets over Liabilities		8,558 5 3
		£9,981 1 9

Assets.

	£ s. d.	£ s. d.
By Society's Funds invested in—		
Reduced 3 per Cent. Stock, £5,401 5s. 2d., worth, on 31st May, 1883, £5,427 5s. 3d., less £665 2s. 3d., reserved to meet Trusts Nos. 6, 7, and 8, stated below	4,762 3 0	
£217 Great Indian Peninsula Railway 4 per Cent. Debenture Stock, worth on 31st May, 1883	235 19 9	
£500 Queensland 4 per Cent. Stock, worth on 31st May, 1883	495 12 6	
		5,493 15 3
,, Subscriptions of the year uncollected	686 14 0	
,, Arrears, estimated as recoverable	300 0 0	
		986 14 0
,, Property of the Society, including Barry's Pictures and Lease		2,000 0 0
,, Advertisements on the Books due and in course of execution*		943 2 0
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1883	460 16 11	
Less by cheque uncashed	20 0 0	
		440 16 11
,, Ditto on Deposit		100 0 0
,, Ditto in hands of Secretary		16 13 7
		£9,981 1 9

* A portion of this sum is liable to charges for printing.

Investments Standing in the Name of the Society.

Ground Rents on Tyssen-Amherst Estate	£4,590 0 0
Consols	391 6 4
New 3 per Cents	388 1 4
Reduced 3 per Cents	5,401 5 2
Metropolitan Railway 4 per Cent. Perpetual Preference Stock	500 0 0
Oude and Rohilcund Railway 5 per Cent. Guaranteed Stock	2,150 0 0
Bombay and Baroda do. do.	2,450 0 0
Canada 4 per Cents	423 0 0
India 4 per Cents	105 18 7
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170 0 0
Queensland 4 per Cents	500 0 0
Cash on deposit with Messrs. Coutts and Co.	100 0 0

Trust Funds included in the above.

1. Dr. Swiney's Bequest	£4,500 0 0	Invested in ground-rents, and chargeable with a sum of £200 once in five years.
2. John Stock Trust	100 0 0	Consols, chargeable with the Award of a Medal.
3. Benjamin Shaw Trust for Industrial Hygiène Prize	133 6 8	,, ,, ,, Interest as a Money Prize.
4. North London Exhibition Trust	157 19 8	,, ,, ,, ,, ,, ,,
5. Fothergill Trust	388 1 4	New 3 per Cents, chargeable with the Award of a Medal.
6. J. Murray, in aid of a Building Fund	50 0 0	Invested in Reduced 3 per Cent. Stock.
7. Subscriptions to an Endowment Fund	525 2 3	
8. Dr. Aldred's Bequest	50 0 0	
9. Thomas Howard's Bequest	500 0 0	,, Metropolitan Railway 4 per Cent. Perpetual Preference Stock.
10. Dr. Cantor's Bequest	5,052 19 8	,, Bombay and Baroda and Oude and Rohilcund Railways 5 per Cent. Guaranteed Stock.
11. Owen Jones Memorial Trust	400 0 0	,, Canada 4 per Cent. Stock, charged with the Award of Prizes to Art Students.
12. Mulready Trust	109 12 9	,, India 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
13. Alfred Davis's Bequest	1,800 0 0	,, Great India Peninsula Railway 4 per Cent. Guaranteed Debenture Stock.
14. Sir Walter Trevelyan Prize	100 0 0	On Deposit with Messrs. Coutts and Co.

The Receipts of the Society set forth above have been credited by Messrs. Coutts and Co.

The Payments set forth above have been made by authority of the Council.

The Assets, represented by Stock at the Bank of England, and securities, cash on deposit, and cash balance in hands of Messrs. Coutts and Co., as above set forth, have been duly verified.

B. Francis Cobb, Owen Roberts. } *Treasurers.*
J. O. Chadwick, *Auditor.*

H. Trueman Wood, *Secretary.*

Society's House, Adelphi, 16th June, 1883.

Proceedings of the Society.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, May 24th; WILLIAM SPOTTISWOODE, LL.D., P.R.S., Vice-President of the Society, in the chair.

The paper read was—

THE DEVELOPMENT OF ELECTRIC LIGHTING.

BY J. E. H. GORDON, B.A.

Manager of the Electric Light Department of the Telegraph Construction and Maintenance Company.

Among all the great industries which in this wonderful last fifty years have been developed, there is none, perhaps, that has had so stormy a birth as the industry which we have met to speak of to-night, namely, that of electric lighting. We must remember that the public know very little indeed about electricity, in fact, nothing. Even in the early days of railways, although there was much ignorance about steam, still everybody had seen a kettle boiling, and had some vague idea of what steam might be, even if he did not know what it could do. But the public do not know what electricity is, nor have they any knowledge of its laws; therefore, at one time, they were ready to believe any statements made to them about electricity. Nothing was too extravagant, too startling, or too ridiculous for the public to believe in the early days of electrical enterprise. We all remember that panic in gas shares, which occurred about three years ago, when numbers of the public rushed to their brokers, and directed them to sell their gas shares at any sacrifice, to throw them away if there was any liability on them even, but to get rid of them. Why? Because a telegram had come across the Atlantic that Mr. Edison said he had made a discovery which would supersede gas. Few remember that, even with the most perfect discovery, it would at least take a little time to provide for an industry involving a re-investment of capital in England alone of about £100,000,000 sterling, for that is about the amount invested in gas. It was imagined that this great change was coming instantly. However, this change did not come instantly. Then they said Mr. Edison was an impostor, and that the electric light was a failure, because it was found that we could not undertake to supply one hundred lights, when the whole plant was made for the supply of one hundred lights only, at the same rate as one hundred gas lights, when they form part of a system supplying, perhaps, one million.

You must not for a moment think that Mr. Edison was to blame for this. Mr. Edison is a genius, and one of the greatest inventors of the age, and he has, in a very high degree, that poetic and prophetic insight which is able to see beyond the trammels of difficulty, and to know in his own mind, for certain, what will come in the future. He saw that the thing could be done, and said so. And, further—it is, perhaps, a failing of inventors, and being an inventor myself I may say it—Mr. Edison, like all inventors, has that enthusiastic imaginative temperament which is necessary for the development of inventive skill, and possibly he may sometimes have slightly confused what he was certain shortly would be done with what had already been done.

Now, this development of electric lighting has suffered to some extent from its enemies, but of course it is understood that gas shareholders are its natural enemies, and will do all they can to retard it; it is perfectly fair and right they should do so. We regard them as fair and open enemies; we are quite willing to fight them on their own ground, and hope the best man will win. But they have not done us much harm—in fact they have done us good. If there had been no other light to fight against, electric lighting would not have developed as fast as it has done. But electric lighting has suffered terribly, not so much from its enemies as from pretended friends. It has suffered much from the operations of persons who, while professing to be interested in electric lighting, and to desire to hasten its adoption, have only been interested in the progress of Stock Exchange operations, and the formation of bubble companies.

Whenever any industry is started which is at all new, this will always occur, and the extent to which it occurs is measured to a certain degree by the credulity, and more by the ignorance, of the public. If companies are brought out in connection with a subject the public know all about, there is not much chance for the public to be deceived; but if it is a subject they know little about, they are easily deceived; and when you come to a subject like electricity, about which the public know nothing, there are special opportunities

for the speculator. I hope the ground is now cleared, and that these bubble companies, having satisfied their promoters, are disappearing, and making way for honest, legitimate enterprise to go on.

Now to turn to the more practical and the more important part of our subject, we have to think what is the problem which has to be solved in the establishment of electric lighting; it is, first, to provide a perfectly steady, perfectly safe and reliable light; and what is very important still, but which is second, to provide that light cheaply. It is no use getting a light a little cheaper than another, if it is to go out or to blink. Our first consideration must be to make the light perfect; the second, following closely, but still second, must be to make it cheap. This problem must be regarded as a whole, I mean the problem of making it perfect. It has been attacked too much in detail, and the reason of that is that, for success in electric lighting, the knowledge of several branches of science is required, which are not often united in the same person; an electrician, for instance, is very often not a first-class engineer. It is no use getting a little more out of your dynamo if that dynamo will not fit the engine; if you have a certain dynamo that works conveniently with your engine, it is no use making the dynamo one or two per cent. better, if the alteration causes you to lose ten per cent. more in transmitting power to it. You must regard the engines, dynamos, mains, &c., all as one complete system, and you must remember that if anything goes wrong, the public will not make excuses for the lamps like we may make in the laboratory. They will not say it was not the dynamo's fault, but it was the engine's fault, or the boiler's fault. All that the public would be concerned with was that on this or that occasion the light went out. Therefore we must not despise anything, however foreign it seems to our subject, if it will help to make the system, regarded as a whole, perfect. The electrician knows very well that the principle of a dynamo is to move a coil of wire through a magnetic field, and he is very apt, when he is a pure electrician, to think that he has invented a wonderful dynamo if he gets a coil of wire that will go through a magnetic field; he says here is a magnet, and here is a coil of wire, the coil is to be thin and the magnet strong, and the coil is to be moved fast through that field. Then some outsider says, "How are you going to secure it, and attach it, and support it?" "Oh," he says, "any practical man can tell you that;" but I am afraid that when "any practical man" has found out that, he is apt to patent it and keep it to himself, and sometimes he says that what the electrican has given him is the very smallest part of the invention. Perfecting dynamos is an engineering problem, quite as much or more than an electrical problem.

We must not spend time in going into the details of electric machines, but there are one or two points I may be pardoned for alluding to. It is bad policy to cheapen your system by endeavouring to greatly cheapen the dynamo. The contract price to be paid by a company for electric lighting plant will be one sum for engines, boilers, dynamos, mains, buildings, &c., and it does not matter if the dynamos are a little cheaper, and the engines dearer, so long as the total sum remains the same. But whatever else we economise in, we must not economise in the dynamo, for this reason, that the cost of the dynamo is comparatively a small fraction of the cost of the plant, but the dynamo is the very vital heart and lungs of the whole affair. If anything is wrong with the dynamo, it is no use having the most perfect engines and the most perfect lamps, the lights will go out. Therefore, the dynamos must be perfect, and any economy, any extreme cheapness that is required, must be achieved in some other part of the plant.

Now, this question brings us to a controversy which has been going on, and has been universally discussed ever since electric lighting was first heard of, and which I think will continue to go on for some time, that is, the controversy between the relative merits of high speed and low-speed dynamos. It is necessary in a dynamo that the coil of armature wire should pass at a certain speed through the magnetic field, and that speed can be obtained in two ways; the wire is wound upon a wheel, and you can either have a small wheel which revolves many times a minute, or a big wheel revolving few times a minute, and you get the same speed of the rim in each case. The controversy between high and low-speed dynamos means this: will you have a small wheel revolving very fast, or a big wheel revolving very slowly. The first and natural opinion is have a small wheel revolving fast, for you can make the dynamo a good deal cheaper that way; it takes up less space, and altogether seems more convenient. I think everyone, when he begins electric lighting work, approves of high-speed machines. I did, myself, at one time, very strongly; in fact, less than two years ago, I

wrote an article in the *Quarterly Review*, in which, if I recollect rightly, I said the dynamos of the future "will, we believe, revolve much more more rapidly than at present; their speed will only be limited by their tendency to fly to pieces." Then my friends and I set to work to build a dynamo on the principles I had laid down in the *Quarterly Review* article. We soon found that in a large high-speed machine there was a great deal of difficulty in getting the power into it at all. You had to put belts to it, in fact a number of belts and counter-shafts, and there was always a good deal of slipping. Then the belts going at high speed used to make a most terrible noise; there was a deafening roar in the dynamo-room, and the whole building used to shake. All these things were bad in themselves, but they were worse in this respect, that all these vibrations, whether of air forming sound, or of the building itself, required mechanical force to produce them, and every bit of that force was stolen from the steam-engine, and taken away from the force that ought to be used in producing light. I suppose this ought to have convinced me that high-speed machines were wrong, but it did not. We went on, we tried a machine, it worked very nicely, indeed, for an hour, and we got excellent electric results, and were very pleased. Then certain vibrations began to get worse, and I thought it advisable to send the workmen away. There was one safe spot where the person attending the machine could stand, from which I was able to watch what happened. The experiment was conducted in a cellar at Wharf-road, all vaulted with brickwork backed by the earth of the street, and it was so hard that when, on some occasion, we wanted to put a spike into it, we were unable to penetrate it at all. After a few hours' work the dynamo flew to pieces with a loud explosion, and I have here some of the few fragments that were left of it. Here you can see the fracture of a massive piece of iron that was caught by it; here are portions of the holders of the revolving magnets. I have not much of it here, the rest of it was picked up in a shovel. The only large piece which was found was a piece which weighed 1½ cwt., which struck the hard wall of the cellar (the distance from the dynamo being about twenty-five feet), and cut a hole two feet in diameter and two feet deep. Another piece skimmed along the vaulted roof, and made a series of grooves in which you could put your two fists. After that experiment we thought we had had nearly enough of high-speed dynamos—in fact, we thought we had nearly enough of dynamos altogether. Here, perhaps, although it hardly belongs properly to the subject of the paper, I must ask your indulgence if I turn aside for a moment, to say a few words of tribute to those friends who, both by their moral and material support, helped me through that very difficult time. After this explosion, when it might have been fairly thought the whole attempt was at an end, my friends met, almost among the ruins of the dynamo, and in a few days they subscribed a large sum of money, and said to me, "Go on; build us another dynamo ten times as large as the first, only," they said, "make it strong enough this time." We set to work and built a second machine, and this time we went on very different lines. We made the wheel enormous, and made it run very slowly, taking good care that the whole thing was strong enough. The first machines had taken two to two and a-half years to make, the second machine took about eight months, and this was last year, and the experiments cost a great deal of money; one thousand pounds went after another, and still there was no result. Things seemed far from completion, and the money which had been handed to me to build the machine was spent three times over before the machine was finished; still my friends said "go on, if it costs three times as much as you expected, you must make it do three times as much work." At last we were all ready to try the experiment, and for the last week or ten days I may say we had given up going to bed; it was of no use, for we could not sleep, we used to go to bed for two or three hours, but we spent nearly all night in the factory. At last my friend, Mr. Clifford, the Telegraph Construction Company's chief engineer, and myself, began the final trial; we began on the Saturday morning, and thought we should be ready to start the engines on Saturday night; we got the steam up, but first one hitch occurred, and then another, before we could start, and at last it was three o'clock on Sunday morning before we made our first trial. That failed completely, the machine did nothing; we looked over it, and saw what was possibly the cause of error, and set to work to change the connections. Now, if you are changing connections in little dynamos, it is simply a matter of unscrewing two or three screws, and changing the wires, but with this large machine, it was not so simple; it took as many men as

could cluster over it until six o'clock in the morning; then we got a little better result, and went home for a few hours' sleep. We started again early on Monday morning, and at nine o'clock on the Monday evening we were ready for the trial. The experiments were made at the Telegraph Construction Company's Works, at Greenwich, works which are about a third of a mile long, and cover fourteen acres; there are 1,200 or 1,400 lights all over the works, and as the cable department was then busy, there were about 1,000 men at work, and a little glimmering gaslight over each lathe. When I turned the valve, the whole place burst into a blaze of daylight at once, and we felt at last rewarded for that three years of anxiety we had had before.

Now, what are the chief advantages of a big machine as compared with a small one? I think the chief advantage of all is that we can dispense with belts. With a big machine we get the necessary velocity by the largeness of the wheel, and, therefore, can cause it to revolve only the number of times in a minute which is not too great for the steam-engine to revolve, and can connect direct to the steam-engine. Mr. Edison was the first to point out the importance of this, and his was the first very large machine which was made. He has constructed a very large dynamo, which works 1,300 of his lamps, equal to about 1,000 20-candle lamps, his being 16-candle. It has been worked extremely successfully in New York, and also in Holborn; and I will now throw on the screen a picture of it, then I will show you some of the important points, not of dynamos generally, but of a large machine as compared to a small one. You know that a dynamo machine consists of some apparatus for causing a coil of wire to revolve opposite a magnetic pole, or else magnetic poles to revolve past a coil of wire; in the one you see before you, the shaft is geared direct to the steam-engine, no belting at all being required; it is driven at the speed of 350 revolutions a minute.

I now come to a very important point, which is where the current is taken off. Of course, if a current has to be taken from a moving coil to fixed wires such as the conductors that go to the streets, there must be sliding or rubbing contact of some sort, and you have all seen in ordinary dynamos the contact brush or commutator, and there is always a little sparking. As the current gets greater, that sparking gets greater, not proportionately, but still it is greater when you get a large machine. I must say myself I think the current for 1,000 or 2,000 lights is about the biggest that can be taken off by rubbing contact, but I never heard that with this 1,300-light machine there has been any difficulty with this. Still, as a matter of prudence, I should not consider it advisable to take enormous currents through rubbing contacts. I am speaking of currents which will supply as many lamps as come from our big gas works. Therefore, when we designed this machine I have been speaking of, we arranged it somewhat differently. We used an arrangement which is not new, but was never applied on a large scale before, namely, causing the magnets to revolve, and the coils to be fixed. That enables the current, however great, to be taken off without sparking at all, there being a metallic connection the whole way from the fixed coils to the mains.

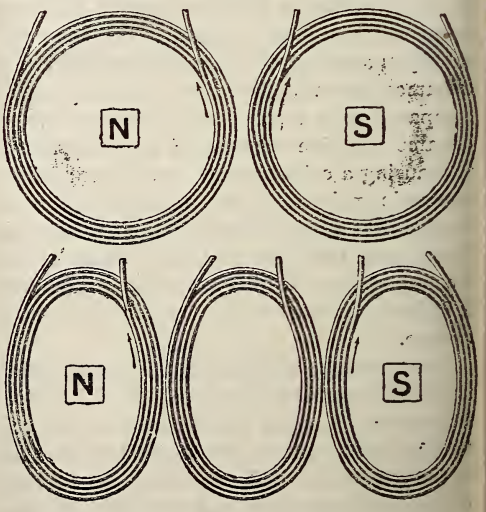
Our machine has been worked up to nearly 2,000 lights, and we were able to get this off a fraction of the coils, and we have no doubt, it will give about 5,000 lights with adequate engine power. We call these 5,000 lights the baby ones; there will be much bigger ones made some day, we hope. There are 32 magnets, which revolve between fixed coils whence the current is taken off. I must be pardoned in my illustration of big machines for going so much into the details of my own, and so little into the details of the excellent machines of Mr. Edison. My excuse must be, first of all, I am not so well acquainted with the details of Mr. Edison's as with my own; and, secondly, from the natural feeling a parent has for his own child, for he always believes it to be the finest child in the world.

We now come to a requirement which is common to all large machines, namely, a method of adjusting and regulating them while they are going. You see we have to keep the pressure constant, and we have a varying demand. We put on a number of lights when we start, and then somebody turns out a number of lights; later on, somebody else turns a number on, and we have to keep the pressure absolutely constant. Now, with any machine, such as this, if a thousand lights, say, are on, and another 500 are put on, the pressure will drop, and the 1,500 lights would not be in proportion so bright as the former 1,000. Similarly, if 500 are taken off, the remaining ones would get brighter, and break the lamps; and, therefore, means for compensating for these changes have to be provided. The way in which the

regulation is done is by varying the strength of the field magnets. These magnets, which are fixed on the big revolving wheel, are not permanent magnets, but are magnetised by the current of a small direct current machine. At present we use a very good little machine made by Mr. Crompton. This small direct current machine is driven by a small separate steam-engine, and by varying the speed of this small steam-engine, we can vary the strength of the current in the magnets, and so we can alter the pressure just as we want it. Of course we have to alter the pressure according to the requirements of the district, and this is the way the regulation is at present done. The picture on the screen represents the regulating room of our works at Greenwich. First of all, we have to see what pressure is right, and for that purpose we employ a photometer, an iron rod which casts two shadows on a screen, one the shadow from a candle and the other the shadow from an electric light further back, the relative distances being so adjusted that the candle power of the lamp is correct at the moment that the two shadows are equal. By shifting the position of the candle we can work to any candle power we prefer. The lamp employed being a fair sample lamp, we know that if that lamp is right all the others are right, but we have one or two connected from different parts of the factory, which can be turned on by means of switches. Now, suppose someone at the other end of the factory turns off 100 lights, when there are a large number on, that would not be perceptible in the factory; but the man here can see the change of brightness much more readily than anyone can in the open room or yard, and he at once sees that the pressure has run up a little bit. He then turns this valve a little, which partly shuts the tap, and diminishes the supply of steam to the small engine, that diminishes the speed and the strength of the magnets, and so takes the pressure down as required. Similarly, if 100 lamps are put on, he finds the brightness drops, and he has to open the valve, and make his small engine run faster. There is one very important feature which it has been necessary to put into this regulating apparatus, and that is due to the property of the human eye to accommodate itself gradually to changes of light. The pupil of the eye expands and contracts, and takes in pretty nearly the same quantity of light, if the illumination is within certain limits. Although the eye is very sensitive to sudden changes of light, yet if you make the change sufficiently slowly, you allow the pupil time to expand or contract, and the change is not noticed very well. Therefore, instead of turning this valve rapidly, it is turned by a slow screw, so that it takes at least a minute to make a change of light equal to one-candle power. The result is that, even if a considerable change has to be made, such a change is never noticed at all. At the back of the room there is a steam-pressure gauge, showing the pressure on the boiler, and an indicator showing the speed of the large engine, and two men stand here on duty, in turns, all night, to work the valve.

You may say that this is an expensive way of regulation, on account of the cost of men's wages; but what we have to consider in the commercial aspect of electric lighting is not the price of working each machine; but the price of working each lamp. It would have been ruinously expensive to have one or two men to attend to a small machine, but when their wages are distributed between 5,000 or 15,000 lamps, it becomes a very small item of expense indeed, although those same wages distributed between 500 or 1,000 would be very extravagant.

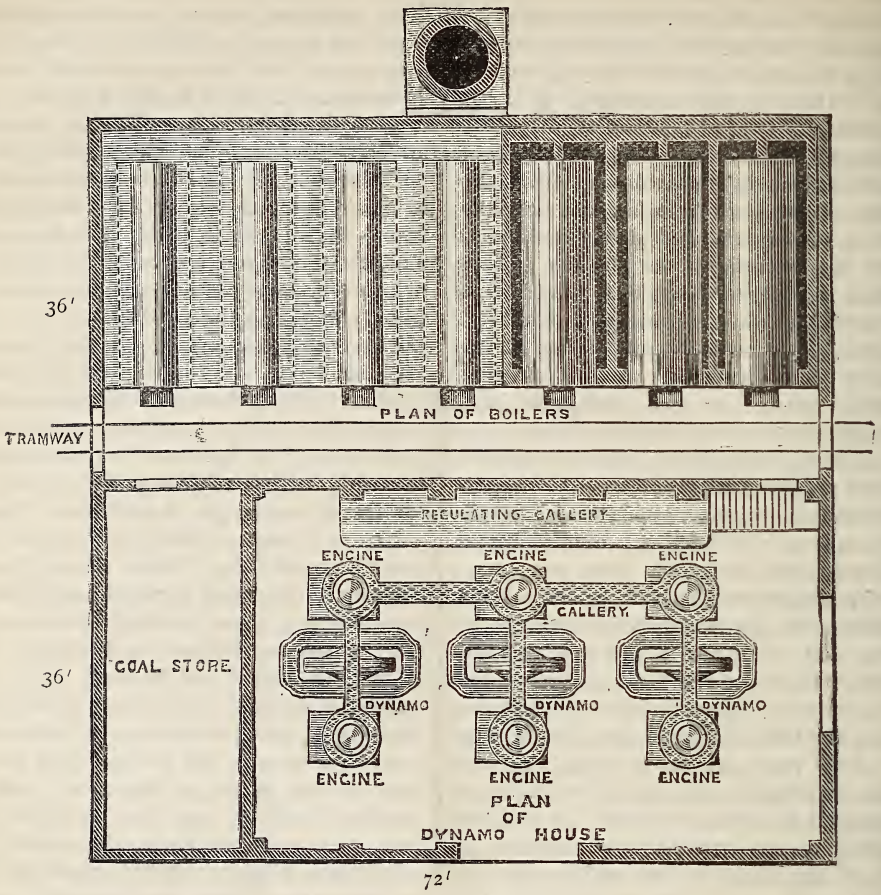
There is one small point about this machine, before we leave the technical part of the subject, which I may be pardoned for mentioning; although it is a purely scientific point, I think it is of some general interest, as showing the kind of difficulties which the designer of any new engineering work has to encounter. In

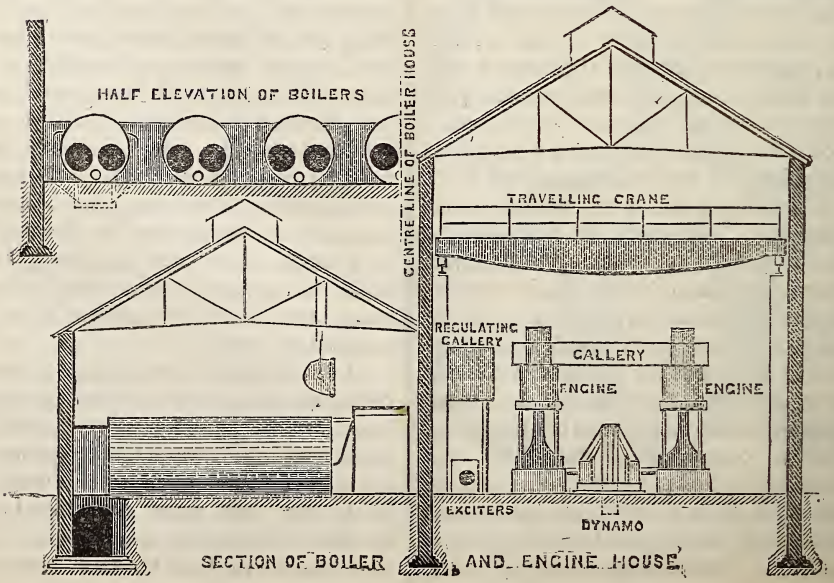


our first model machine we made the same number of coils as there were magnets; that is to say, there were a series of round bobbins in that disc of the machine, and a similar number

on the revolving wheel, and currents were induced in the way usual in that class of machine; in fact, the arrangement was something as shown in the upper part of the diagram on p. 782. The two centres marked "N" and "S" represent the two poles of neighbouring magnets, and these coils represent the coils of wire acted upon by them as they pass, the direction of the currents being the direction shown by the arrows, one going each way. On the first experiment we put one coil on the small experimental machine, and got a good result, but when we put on the next coil alongside, we found the mutual action of the two coils pulled down the amount of light produced nearly 50 per cent., in fact, diminished the power of the machine nearly one half. A little study of the laws of induction will show you how that occurred. It is a well-known law that a varying current, under certain circumstances, will induce a current in an opposite direction to itself. Here was a current travelling in one direction, which induced a current in the opposite direction, in a neighbouring coil, so that we got two opposite currents, and we only got the difference between the actual current induced by the magnet, and the back current induced by the next coil. The practical result was, that the efficient lighting we got out of the machine was reduced to about one-half. To get over the difficulty, we arranged the machine as shown in the diagram; we made a number of fixed coils, twice the number of the magnetic poles, flattened them, and squeezed them together, so that each pair of coils was acted on alternately, and between each there was a coil which was not in use at the moment; therefore, although there was a tendency to induce back currents, yet each pair of active coils being separated by an intervening coil, the action was so small as not to be perceptible, and thus the quantity of electricity we could get out of the machines was nearly doubled. We hoped we had now got the dynamo perfect, and that we had solved the problem, and got to the end of our troubles. We had got the dynamo as perfect as we knew how, but we found our troubles only beginning. It is a small portion of the problem of electric lighting to get the dynamo perfect, because there are so many details to be attended to. In putting up a plant for 10,000 lights, in the middle of a populous town—a town of wealthy houses, where the inhabitants do not at all like smoke and waste steam—there are a great many matters to be attended to. On the diagram (p. 784) I have shown a plant for an installation for 10,000 lights, which we hope to have the opportunity of putting up soon. This is not the only way, perhaps, not the best way in which it could be worked out, but it is one way which has commended itself to us. There is the plant, an end elevation, and an elevation of the boiler house. Of course, we have to get our boilers in pretty close; there are seven boilers here. Then there is the dynamo house with three dynamos, each working 5,000 lights, two to be always at work, and one in reserve, the whole plant being designed for 10,000. Then we have an arrangement so that the mains are laid double. That is to say, each house has half its lights from one dynamo, and half from another, so that, supposing an earthquake upset one of the dynamos and put it wrong, then only half the lights would go out; the town would not be put in darkness. There is one class of accident which may occur to any machine, and it is, I think, about the only difficulty which large dynamos are liable to, that is getting a hot bearing. But an engine driver is not worth his wages if he cannot keep an engine with a hot bearing going for a quarter of an hour, and supposing he finds he has a hot bearing, all he has to do is to start the spare dynamo, get the speed of that the same as the speed on the other, start the exciting engines, get the pressures constant, then pull over the switch, and all that will happen will be a slight jump in the light, and then the engineer may instantly stop the heated dynamo, and attend to the bearing. The engines are condensing engines, each dynamo to have two, and they will require about 510 indicated horse-power when at full work. Each engine is calculated to have a power of 275 indicated horse-power, so as to give about 550 horse-power available, which is sufficient reserve. Again, there are boilers in reserve; $4\frac{1}{2}$ boilers would give sufficient power, so that there will be always two boilers standing quite idle, which can be cleaned. There is a large crane running along the roof, which we used to put the machinery into its place, and to lift any part of it as may be required for repairs.

I have spoken of condensing-engines, and I think we must have condensing-engines, at least, in all important and wealthy towns. There are certain advantages of economy which are matters quite open to discussion, but I think they are more economical even in London, where water is expensive. We have seen lots of engines for small electric light


36'
PLAN OF BOILERS
TRAMWAY
REGULATING GALLERY
ENGINE
ENGINE
ENGINE
GALLERY
36'
COAL STORE
DYNAMO
DYNAMO
DYNAMO
ENGINE
ENGINE
ENGINE
PLAN OF DYNAMO HOUSE
72'


HALF ELEVATION OF BOILERS
CENTRE LINE OF BOILER HOUSE
TRAVELLING CRANE
REGULATING GALLERY
GALLERY
ENGINE
ENGINE
EXCITERS
DYNAMO
SECTION OF BOILER AND ENGINE HOUSE

plants which are not condensing, and they do very well, but they have all been small. If you only want 10 or 20, 50 or even 100 horse-power; you may send the waste steam up the chimney, it disappears in the air, and you hear no more about it: but if you have over 1,000 horse-power, even in this station, which is regarded as a small experimental one, and send the waste steam into the air, two or three unpleasant things will happen. First, you will choke the chimney, because the effect of the steam will be to cake the soot, and so spoil the draught, and some day you would find the furnace would not draw; secondly, that steam would attract all the London blacks, and form a fog to which our present fogs would be as nothing, and that would be a bad introduction of the electric light, one of the great arguments in favour of which has been that it is to keep our houses clean. With a condensing-engine, the waste steam is all condensed, and goes away in the form of water. It is a hard saying to say there must be condensing-engines, because condensing-engines very greatly increase the first cost, but, in spite of this, I say we must make up our minds that, if we have the electric light at all, we must be prepared to pay for condensing-engines. We must remember, too, that there is a special clause in the Electric Lighting Act, and in the draft provisional orders, pointing out that no Parliamentary powers, conferred on a corporate or other body, are in any way to be regarded as a protection to them against being indicted for a nuisance, if they should cause one. Therefore, we must arrange the plant so as not to cause a nuisance. With electricity there is more loss in transmitting it to a long distance than with gas, so that we cannot place our electric lighting machines at a great distance from the town. About half a-mile radius is a convenient distance, and, therefore, the stations must be tolerably central.

As to the space required, these engine-houses, for a 10,000 light plant, require 72 feet square; that is to say, two strips, 72 feet by 36 feet. If it were more convenient for the site, we might set the boiler-house end to end with the engine-house. Then we have to get a supply of coals. We cannot put the coals on with a shovel when working on this scale. We have to think of bringing the coals in through a populous neighbourhood, storing them so as not to cause a nuisance, and feeding them so as not to cause smoke, and also so as not to have an enormous staff of firemen, whose wages would run away with our profits. We may assume at once that we must have what are called mechanical stokers to the boilers; that is to say, that each furnace is fed, not by shovelling in coals, but by a little steam apparatus, by which the coal is discharged into a hopper, and slowly screwed into the furnace. That has the advantage that it enables us to burn much cheaper coal than we could otherwise do. We have here a coal store, which will hold about three weeks' winter supply, so that we need only coal about once a fortnight, and we can do it at night. The floor of this coal store is higher than the level of the boilers. The coal waggons will stop outside, there is a small crane by which the sacks are all taken up, the coal is emptied into the store until it is full, and that is the only time the coal is lifted. Near the bottom of the coal store there is a trap-door, and the coal comes out, and is run into trucks running on a raised tramway, and is discharged by its own weight into the hoppers of the stokers. There is, again, a second underground tramway for removing the ashes, so that the coal requires no handling at all.

You may say this is all very pretty, it is a very nice dream for the future, but what is it going to cost? People are not going to buy electric light at two or three times the cost of gas. That is a very important question, and he would be a very bold man who would speak too strongly on the subject, but yet I think we may say, not that electric lighting will be dearer than gas, but that it will be almost immediately cheaper. I believe that in the future it will be about two-thirds the price of gas; and I am quite certain that at present it can be supplied in London at the same price as gas, when supplied on a moderately large scale. I have worked some estimates (see next page) of the capital expenditure, and the working cost for an electric lighting plant, and there is not much difficulty in getting out the total expenditure accurately. The doubtful point is what the revenue will be. The estimates show the expenditure of capital and the annual expenses for electric lighting plant of two sizes, one for the supply of electricity to 60,000 lamps of 20-candle power, and the other to 10,000 lamps. In each case we can always count upon putting up half as many more lamps as we should supply, for never more than two-thirds of the total number would be alight at the same instant. First comes the capital expenditure, viz., the price weich would be charged by the manufacturers for the whole plant, that is, for machines, dy-

PLANT TO SUPPLY ELECTRICITY SIMULTANEOUSLY TO 60,000 LAMPS OF 20 CANDLE-POWER EACH, EQUAL TO 85,000 OF 14 CANDLES. CAPITAL EXPENDITURE, £220,000.

Annual Expenditure, lamps burning 2,000 hours per annum.

	£
Depreciation and repairs	8,000
Slack coal, at 11s.	7,100
Water, at 6d. per 1,000 gallons	7,100
Oil, &c.	850
Wages and superintendence (63 persons)	5,390
Rent, rates, and taxes	1,000
Office expenses	500
Directors' fees	1,000
Renewal of incandescent lamps	12,000
10 per cent. of dividend on capital	22,000
Total required revenue	£64,940

85,000 14-candle gas burners burn, in 2,000 hours, 850,000,000 cubic feet, which would produce £65,000 at 1s. 6¼d. per 1,000 cubic feet.

PLANT TO SUPPLY ELECTRICITY SIMULTANEOUSLY TO 10,000 LAMPS OF 20 CANDLE-POWER EACH, EQUAL TO 14,000 OF 14 CANDLES. CAPITAL EXPENDITURE, £50,000.

Annual Expenditure, lamps burning 2,000 hours per annum.

	£
Depreciation and repairs	1,500
Slack coal, at 11s	1,230
Water, at 6d. per 1,000 gallons	1,230
Oil, &c.	150
Wages and superintendence (30 persons)	2,968
Rent, rates, and taxes	250
Office expenses	250
Directors' fees	350
Renewal of incandescent lamps	2,000
10 per cent. dividend on capital	5,000
Total required revenue	£14,928

14,000 14-candle gas burners burn, in 2,000 hours, 140,000,000 cubic feet, which would produce £15,000 at 2s. 1¾d. per 1,000 cubic feet.

Gas in London is 3s. 2d. per 1,000 feet.

N.B.—It is not expected that each lamp erected will average 2,000 hours per annum, but that 2,000 hours is the average consumption of the maximum number alight at one time. Thus, if a house has thirty lamps, but not more than eighteen alight at once, the average consumption of that house will be 18 × 2,000 = 36,000 lamp-hours per annum.

namos, mains, chimneys, and, in fact, bringing a pair of poles into every house, and starting the concern. Those are not estimated sums; they are taken from tenders which my company has actually furnished to corporations, so we know that the expenditure would not exceed those prices, because we have actually offered to contract to do it for the terms mentioned. The annual expenditure is another matter. It depends to a great extent on the number of hours per annum the lights are burning. I have spoken here of 2,000 hours, but I find there has been a good deal of misunderstanding about what is meant by that. I do not mean that all the lights will burn for 2,000 hours, but what I mean is, that the average of the maximum number of lights burning at once will be about 2,000 hours. For instance, suppose in any particular house we put up 30 lamps; there are not, as a rule, more than 18 lamps burning at once, and I should not call the expenditure of that house 30 times 2,000 hours, but only 18 times 2,000 hours. We need not provide, in plant, more than sufficient for the total number of lamps likely to be burning at once. I was talking to a gas engineer the other day, of very great experience, and he thought I might count on never having more than half the lamps alight at once, but, to be on the safe side, I have taken it at two-thirds. The number of hours lamps burn depends where they are. Street lamps burn nearly 4,000 hours; then come clubs, which burn over 2,000, but in private houses they would burn less. I think, with that reservation, that when we are speaking of the maximum number alight at once, and not of the maximum number put up, we may say that 2,000 hours is not very far wrong. Here is the way the expenditure is calculated. Every year put aside something for depreciation. Of course the first year there would be nothing spent, and perhaps not for a few years, but some day new boilers will be required, and for that we should go on the reserve fund; therefore each year a certain sum must be put aside for repairs. I have taken that at about £1,500—a certain per-centage on one part of the plant, and a different per-centage on another. It is a large per-centage on the boilers, a smaller per-centage on the dynamos, a smaller still on the mains, and a smaller still on the buildings. When the dynamos are run at a small speed, you can diminish the depreciation on dynamos and buildings; high-speed dynamos shake buildings to pieces before very long. Then comes slack coal at 11s. The consumption of coal has not been guessed at, but is taken by me from figures furnished by Mr. Hill, chief engineer at the Royal Mint. They have lately had a pair of engines put up by Messrs. Maudsley and Field, of 500 horse-power, about the

type of engine we think of using. They are not put up for electric lighting purposes, but for driving the machinery of the Mint; they have been working seven or eight months, and the figures for the consumption of coal are from the actual bills. By using mechanical stokers, we can use slack coal at 11s., instead of steam coal at 18s. Mechanical stokers do not give us quite an advantage in the ratio of 11 to 18, because 1 lb. of slack coal does not produce so much steam as 1 lb. of good coal, but still there is a very great saving in using slack—about 13 to 18. The actual consumption at the Mint has been 2¼ lbs. of slack coal per indicated horse-power per hour. From that 11s. that item is taken of £1,230. Then there is the water for condensing purposes. Where we get waterside premises, that will cost nothing; but in central stations we must reckon 6d. per 1,000 gallons, and a rough and ready rule is, that the water costs about the same as the coal when you have to pay for it; and, therefore, I have put it at the same price. Then oil is a small item; wages and superintendence includes the chief electrician, chief engineer, and various workmen required for small repairs. It does not include any large repairs, which are included in the first item. To be in the dark room, and attend to each engine and dynamo, requires three men always in attendance, *i.e.*, one engine-driver, one labourer, and one man in the dark room; each of those work eight hours, so that you require three shifts of men. That makes a man's work 56 hours a week, 54 being the ordinary workman's time. They work, of course, 7 days a week. Then there is rent and taxes, interest, directors' fees, and renewal of lamps. These must be renewed free of expense, that is, the expense of renewing them must be included in the charge for electricity, whatever it is. I do not mean if the glass of the lamp is broken it is to be renewed; but when a lamp has been destroyed by the current, it is to be renewed. When the lamp is broken by the current, the carbon alone breaks, not the glass, and the rule will be when the lamp has broken down, but the glass is intact, it can be exchanged without charge for a new one; but if the glass is broken, it follows it is broken by violence, and must be paid for. The total required revenue, including 10 per cent. dividend, you see is £14,928.

The light obtained from 10,000 20-candle lamps is the same as obtained from 14,000 14-candle lamps burning 5 ft. of gas an hour, and they, burning for 2,000 hours, burn 140 million cubic feet of gas, which produces £15,000, which is the required revenue if gas is charged at 2s. 1¼d., the price in London being 3s. 2d. On the larger scale the economy is great. The larger scale we work on the cheaper per lamp will the light be. The light, of course, will have to be supplied by meter, but about that I must postpone speaking to another time.

The introduction of electric lighting has, of course, been attended with many difficulties, but I do not think it has been attended with much more difficulty than must necessarily attend the introduction of any new industry requiring a great re-investment of capital. People who have capital invested in something paying well, are shy of taking it out and putting it into something new. If you go to a corporation and say, "If you will spend £100,000 in electric lighting plant you will make a good profit," they will naturally say, "That is all very well, but here is the money we are making from gas, and we prefer that;" and then they say, "Why do not you go in yourselves for this? If it is a good investment, invest your own capital in it, and show us practically it is so." I will not say that is not somewhat hard upon us, but, on the whole, it is a fair enough challenge, and we have made up our minds to accept it. I am not at liberty to say what arrangements are being made, but I hope I shall shortly be able to commence putting up in the West-end of London such a plant as we have already erected; and we made an offer to a vestry, in a district in which we propose to put up the lighting, that we will guarantee that the maximum charge for a quantity of electricity equal to 1,000 feet of gas, shall never exceed 3s., and shall be reduced if we can do it. I will not enlarge any more on this, as it would savour much of a very vague scheme, for you to listen to-day to what we propose to do, and it would savour somewhat of boasting, for me to say it; but if this Society would do me the honour, in about a year's time, to ask me to read a paper before them again, then, if our work turns out as I hope and expect, I may be able to tell them not what we hope to do, but what we have actually accomplished.

DISCUSSION.

Mr. George Offor, Manager of the South-Eastern Brush Electric Light and Power Company, while thanking Mr. Gordon for the valuable informa-

tion he had given, said he should like to make a few observations on this interesting subject, being practically engaged as manager of electric lighting companies, and, therefore, somewhat familiar with it. In the first place, with regard to the practical difficulties experienced in introducing electric lighting, referring rather to the commercial than to the scientific aspect of the question, he did not entirely agree with Mr. Gordon that the industry had been materially retarded by the two circumstances he had mentioned, namely, the opposition of the gas companies and Stock Exchange jobbery. On the contrary, although to some extent the mania which existed for electric lighting shares twelve months ago was to be deplored, that enthusiasm of the public placed a very large amount of capital at the disposal of those who were anxious to develop this interest. Though Mr. Gordon, having friends who believed in him, had the requisite amount placed at his disposal for experimenting, he feared he was one of a favoured few, and that, so far as Stock Exchange gambling was concerned, the electric lighting industry had rather to thank it than otherwise. The real difficulty they had to contend with was not any indisposition on the part of the public to adopt the new mode of illumination, because they were now to a large extent familiar with it, and as to the question of price, they were already aware of the fact that it could, with a fair amount of lighting, be supplied at about the cost of gas. The difficulty experienced had been this, that they had not possessed the power to supply. They were now obtaining provisional orders under the Electric Lighting Act, but they had not got them yet; they had no power to take up streets, and put down mains, to supply the public in the same easy way that they were supplied with gas. Up to the present, they had been limited to large factories, where the power was available, and a large amount of light was required, but even that had been checked to some extent, because the public had been greatly in doubt as to which was the best system. Twelve months, ago there was a great champion of one particular system, and no doubt he had a great deal to do with the development of the industry within the last year or two, but he changed his views, and took up with a machine of the same character as had been described that night; and the public began to think if this champion has changed his views, we had better pause before we put down plant which would require thousands of pounds. With regard to the system described to-night, it seemed in many respects defective. What was required in electric lighting, for domestic purposes, was a steady light which could be regulated without the aid of two men, however intelligent they may be, to watch whether the lights were being turned on, or turned off, and then to turn a wheel to regulate the speeds, to prevent too much or too little current going into the lamps. They wanted an automatic arrangement for keeping the lamp steady, and a constant supply, whether an engine broke down or not. Now, in the development of electric lighting, both these objects had been obtained. He had been running regulators at Colchester for some months, where he had turned off the lamps put on to a frame one by one, until he had only a single lamp burning, and that had been regulated entirely automatically, so that whether there were only one lamp or 100 it would make no difference, a single lamp would burn with the same amount of current as 100. This might be seen at Colchester at any time, where they were lighting a number of hotels and shops in the High-street, and the business was increasing, because there they had the power of putting down mains, and supplying the public in the same way as they were supplied with gas. Then, were they sure, under the system of Mr. Gordon, to get a constant supply without any check by the breaking down of machines. It was true that, by the expenditure of a certain amount of capital, you might have a reserve machine, but a reserve machine of such a gigantic size meant a large amount of capital, and even that reserve machine could not be put into action at once if one of the others broke down, and if the bearings of both machines in connection broke down, the reserve would only take the place of one, and in any case there would be a certain delay. That difficulty was got over by the only way, in his humble judgment, which was suitable for domestic lighting, namely, by means of a storage battery. In that way, if a machine broke down, you had a supply of electricity to draw upon, and, consequently, you might have the light day and night without keeping the station constantly going. Mr. Gordon had pointed out the advantage of the large machines, that you could dispense with the belt, but he was probably aware that there were steam-engines in connection with dynamos which ran direct without any belt. He might mention Hodson's rotary engine, which was running a dynamo without any bands, and there were many important engines, with dynamos fixed to them, which ran in the same way. Again, something should be said in favour of small installations. When electric lighting involved such large figures, and such very large machines, he was not at all surprised to hear that local authorities suggested that a trial on so large a scale should be made at the risk, in the first instance, of those who believed in it. He believed the great bulk of the business they were likely to do for some time would consist of small installations, beginning with 100, 200, or 300 lamps, and increasing gradually. How did gas companies supply a town? By means of large gas holders from which they drew all that was required, and that was what his company promised to do; viz., by a storage system established in different parts of the town, and from that, drawing off, as from gasometers, the supply of current required by the public. Mr. Gordon had pointed out that, under his system, the lighting station should not be at any great distance from the supply, but that was not necessary under the system of the companies he managed. Their stations might

be many miles away, the only inconvenience being the length of wire required to connect the stations with the storage batteries; but, by the use of a high tension machine, the current could be conveyed a long distance at a very moderate expense, and the battery stored in this way, so that they did not need to bring the lighting stations into the more expensive parts of the town, or to create a nuisance there, however unimportant. He had had the dynamo running for many months, and had received no complaints, even from the neighbours. He had also had offices lit for the last eight months by means of the storage system. He believed there was a great future for electric lighting, because they were now obtaining powers under the Act. The companies he represented had already agreed with local authorities and the Board of Trade, for provisional orders for fourteen towns, and as soon as the necessary Act of Parliament was passed, the arrangements would be carried out. He knew from observations and inquiry that the public was quite ready to take the new illuminant, as soon as they were able to supply it in the same simple effective way that gas was supplied.

Mr. Wm. Lant Carpenter said he might confirm the remarks of the last speaker, with regard to the automatic regulation. Last February he was lecturing at Lincoln on this subject, and at the end of the lecture Mr. Robey (of the engineering firm of Robey and Co.) said he should like very much to show him an automatic regulator for electric lighting which he had arranged, and had had working for six months, but he was going to run it a year before he brought it out. The principle of it was the action upon the steam valve of an electromagnetic arrangement, the power of which depended upon the strength of the current passing through it. Unfortunately, he was obliged to leave Lincoln without being able to see it, but he gave it on the authority of Mr. Robey, and on that of Professor Silvanus Thompson, who told him that he was well satisfied with it.

Mr. Liggins asked if this estimate differed in any respect from that given by Sir William Siemens in his address, at the opening of the Session, the figures of which he could not bear in mind. It was all very well for gentlemen to say the public did not understand electricity; of course they did not, nor did they understand gas, but what they did desire was to possess the best illuminant at a fair and reasonable price. The reason they had not been able to get it was that so many different companies advertised in the public prints, that the public was naturally cautious until some company had made its system a success. Until they did that, such papers as that of to-night, which had only pointed out an enormous number of difficulties, many of which might have been foreseen, only complicated the matter. The danger of rapidly revolving machinery was by no means unknown; and with regard to the description of boilers, the arrangement of machinery, the burning the slack, and so on, that had nothing whatever to do with electricity. They knew how to get good engines to drive any machine required to produce either one motion or another; but the public did not know the company to which they could go, and say, here is our parish, tear up our streets, and lay wires beside the gas mains, and let us have a better light than we have ever had before, at a more reasonable price. Until some company came forward with something like a certainty—without that doubt which must attach to systems—he was afraid there would be nothing in the near future which would give the public the satisfaction they desired.

Mr. Gore Brown asked what would be the depreciation on a cumulator when it had been used for 2,000 hours; and at what ratio that depreciation progressed as the cumulator got older?

Mr. C. G. Gümpel said he must agree with Mr. Gordon that the greatest difficulty electric lighting had had to contend with was stock-jobbery. What had caused the indifference shown to electric lighting was not the want of powers which Parliament had withheld, but chiefly the absolute loss which had been brought about by speculators. When they heard of the large sums which had been given to electric companies by the public, he would remind them that those sums were not paid to inventors, but were paid to promoters—to men who were the intermediaries between the practical men and the investor. He thought the history of this speculation ought to be written as a warning to future undertakings. We lived in a very different age to that of eighty years ago, when gas first made its appearance, and did now in five years what was then done in thirty. The first speaker had referred to an automatic regulator, and there was no question that they required it. As Newcomen in his first steam-engine required someone to regulate the admission of steam to the engine, so someone was now required to keep the light steady, but the time would come when it would be done automatically. The regulators Mr. Robey had tried might be perfect, but at the present time there was no practical regulator in the market. Professors still spoke about dynamos which kept a constant potential at their terminals, and one suggested one plan and one another, but those acquainted with electrical literature would know how many different plans had been adapted. When the doctors themselves did not agree, what could be done? Mr. Gordon never said a truer word than when he referred to the necessity of making the the plant of such a size that lighting could practically be introduced. It must be remembered that in introducing electricity they had to compete with gas, where one large gas-works supplied a whole town, and the question was to give the plant such a form as

to take from a single engine enough power to supply the light required. They did not want small installations, for which it would be easy to devise small machines, and when they were recommended, he imagined the wish was father to the thought. They wanted larger installations, because you could get them cheaper, as had been shown in the figures. Every electrician knew that. It was the same with gas. If you put up gasworks in your own house, you could not make the gas for 3s. 2d. a thousand feet. Mr. Gordon had solved the one great question of making a machine large enough to supply a town of medium size, and whenever the history of electric lighting was written, his name would stand forward as one who had shown the way. With regard to the storage battery, Mr. Offer was connected with the company which supported cumulative batteries, and hence it was necessary that he should advocate them; but Prof. Lodge, in that room a few days ago, speaking of the nature of storage batteries, said they were all very nice as long as you used them. You might charge them and discharge them, and they would act as long as you did so, but you must not let them stand. If you let them stand for any length of time, you required a very strong current to break through that thick coating of sulphate of lead which was formed on them, making an insulator which you could not penetrate. Suppose you had a cumulator battery in a house, and went out of town for a few weeks, and let it stand; when you came back and turned on the lights, the battery would not charge, and you might wait until doomsday, but you would not get a current into it or out of it. He believed there were points connected with cumulator batteries which would make it a long time before their manufacture took a practical form. He had worked at the subject for five months, and had met with many drawbacks in their working.

Mr. Woodhouse Rawson said the figures which had been given were most valuable, and when they appeared in print must strike the public, especially in many places, particularly abroad, where gas cost 20s. a thousand; it would lead people to inquire, and see if there was not something in electric lighting. He would remark that it was not the price of the current, but the price of the light which was important, and the question was what you could get out of the lamps. If with a certain current you could double the illuminating power, you at once reduced the cost 50 per cent. Up to the present time incandescent lamps had not been worked at so much as the other parts of the plant, and there was no doubt they would be greatly improved, so that, with a certain current, a lamp of a greater power would be obtained, and the price of the lamp reduced. They would then be able to run lamps with much higher candle-power. An ordinary lamp would now give twenty candle-power, with seventy volt-amperes, and last 2,000 hours; but if the price of the lamp could be reduced, you could afford to work it for only 1,000 hours, and could get so much more light. The price of gas would, no doubt, come down; and the products which now fetched a good deal of money, if gas were less used, would become higher, and, therefore, electric lighting would have still further competition to meet.

Mr. Gordon, in reply, said he had listened with a great deal of interest to the remarks which had been made, and it was very useful to hear the views of other persons acquainted with the subject. With regard to the question of Stock Exchange operations, he did not think that was the place to discuss it. All he could say was, he did not agree with Mr. Offer, and nothing he had said had caused him to alter his opinion. He must leave it to the audience to say whether wild and reckless speculation, not in electric lighting, but in paper shares representing electric lighting, was likely to cause the public to adopt it as a safe and steady investment. With regard to the controversy between high and low speed dynamos, it had been going on for a long time, and was not finished yet, and it would probably take some years of work before the question was thoroughly decided. He was speaking chiefly not of what was used in small installations, but what was wanted on a large scale to compete with gas. With regard to driving direct from high-speed engines, he had seen nearly all such engines which were made, and there were plenty which would work very nicely, but he never saw a high-speed steam-engine which worked 500 revolutions—and the "Hudson" worked 1,500—that would be guaranteed for a year. He stood near one the other day for a few minutes, working at about 1,200 or 1,500 revolutions, and the noise was extraordinary; the whole place shook and rattled, and you felt, although it might last six months, or perhaps one year or two, the item on depreciation of plant of that kind would be something like ten times what he had put down. He believed he had been the only electric engineer in England who had persistently said that storage batteries were worthless on a large scale. He was much interested the other day in the report of an interview with Mr. Edison, in which he expressed his opinion, in that racy American language could hardly be repeated in England, but which at least showed that he did not think very much of storage batteries, and which could be seen in the *Electrician*. Storage was not analogous to pumping gas into gas reservoirs. You could not store electricity; you stored energy, and the analogy to storing energy was winding up a spring or pumping up water to a high cistern. Suppose you had a steam-engine which worked a quantity of machinery in a large factory, what would be thought if some one came to you and said if your engine broke down, the shop must stop, so you must have storage; and told you to take off the belt, use the engine to pump water into a high reservoir, and let the water run down again and turn a turbine, and drive a shaft, and then you would be sure not to break down; they would not think much of the practical nature of such advice

and if he added you must pump it into a cistern which leaks very badly, they would think still worse of him. Storage certainly had its uses, particularly in small plant. If you had a little plant in a country house, where the steam-engine which did the pumping did a little electric lighting, and the wages of the engine-driver would double or treble the expense, and you wanted the gardener to attend to it, who went home at 6 o'clock, then have storage; because if you lost half or two-thirds it did not matter, it would be cheaper than paying an engine-driver. But when you had plant of the size to compete with gas, you could afford to have men up all night. A question had been asked what would be the state of a storage battery after 2,000 hours. He had never heard of one which had worked 2,000 hours. With regard to capital expenditure, a point was made that a spare machine meant expenditure, and, therefore, storage batteries ought to be used instead, but the best storage batteries now in the market, capable of storing up current for 5,000 lamps, would cost more than a spare machine, he should think probably two or three times as much. As to regulation, he might say that all through the paper he had spoken, not of what they hoped would succeed, but what was actually practical. He had every hope that they would yet have automatic regulators, and he had experiments now going on, but he did not feel justified in speaking of this as an accomplished fact until they had succeeded. If anybody would bring them a first-rate automatic regulator, they would be glad, if they found it useful, to adopt it, and pay royalty on it; the market was open to anybody at present. He was not aware of any regulator which worked perfectly with a large machine, so he had thought it better to discuss the matter, assuming the more expensive method, if hand regulation was to be adopted. With a small machine, automatic regulation was very useful and important, but with big machinery it was not always the wisest thing. In their experience at Greenwich, of coiling submarine cables into tanks, it was found better that it should be done by hand. They had tried a number of different patents for automatic coiling machines, but had not adopted any of them. If you wanted to reel cotton, you must regulate the flow by machinery, because you could not afford a man to each reel; but with a cable of the value of £50,000, a man more or less did not matter very much, and very often the expediency came in which made them decide to use hand regulation in preference. Still they had no prejudice, and were perfectly ready to employ automatic regulation if it were perfectly certain, and did not require a man to watch it. The question of incandescent lamps was very important and interesting, and he had all manner of hopes about the future, but he did not want the public to think that electric lighting people were mad, and if he told them what he believed would be done in the future they would not believe him; therefore he preferred to speak of what was actually accomplished, so in the capital expenditure he spoke not of estimates but of actual tenders. It was perfectly certain that every improvement in the lamps was a direct gain to electric lighting companies and the public. Engines, dynamos, mains, transferred the energy of coal or water into electricity, and the more perfect the dynamo, the more electricity you obtained for so much fuel. But then before the electricity came to be of any use to the public it had to be changed again into light, and the quantity of that light produced depended on the lamp. The cost of the light depended on the amount of energy consumed, and that depended on the temperature which the filament would stand; the higher you could raise the temperature the higher would be the candle-power per horse-power. To give a simple illustration, if you took a red-hot poker into a room, there was a great deal of energy but very little light; but if you had a little platinum spiral made white-hot, there would not be one-tenth the energy, but much more light. Step by step, as the manufacture of lamps advanced, they would be able to work them at a higher temperature and still be able to guarantee them for 2,000 hours, and with every step of that kind there would be a great gain. Therefore, they were looking forward to the perfecting of the lamp as a means of perfecting electric lighting, and meeting every reduction in price which the gas companies would make. He had endeavoured to speak not of these fascinating expectations they all indulged in, but what was required for a plant which a responsible company was now prepared not only to erect, but to guarantee the successful working of.

The CHAIRMAN, in proposing a vote of thanks to Mr. Gordon, said they were very fortunate in having, as a lecturer, a gentleman who was as eminent on the scientific side of the subject as he was on the practical and constructive side. He had told them something of the difficulties which he, like all other inventors, had encountered, but he had not told them the long and painful struggles which the inventor had to grapple with before he got fairly into his work. If he had justly extolled the pleasing tendency which the subjects which now occupied the public mind had, in adding to its intellectual strength, a sense of responsibility over those more literary subjects with which they were formerly occupied, he might add that not only was the intellectual capacity of the nation strengthened by devoting itself to these subjects, but its moral sinews were also equally strengthened. They all knew, by reading biographies of those who had contributed most to the wealth and convenience of life, that they were really the heroes of modern days, and to that list Mr. Gordon made no exception. In pointing out the advantages of the system with which he was most familiar, he was sure it was not his intention to exalt it above every other, still less to represent it as the system of the future, but merely to exemplify the general subject

of electric lighting by that form of it in which he was best acquainted.

The vote of thanks was carried unanimously.

Correspondence.

QUEENSLAND.

As I was prevented from attending Mr. A. J. Stanesby's practical and interesting lecture, and having recently made an exploration of the country which formed the subject-matter, in company with General Fielding, for the proposed Australian Trans-Continental Railway, I beg to add the following to the discussion. With regard to carrying firearms, it would be unnecessary for emigrants to be equipped with these, so far as protecting themselves from the aborigines in any district they would be likely to settle, where they would be as safe as if they were in Great Britain. Although we were so equipped, it was more to provide a food supply than from any fear of attack from the natives. This, of course, would not apply to the less explored parts, as, for instance, in the vicinity of Point Parker, and at the mouth of the Batavia River, in York Peninsula. At the former of these places an attempt at surprise was made upon our camp during the night by about one hundred of these aborigines, but a few shots fired over their heads effectually frightened them, and no further intrusion was attempted during our stay. The natives of the localities above-mentioned—men, women, and children—are entirely naked, feed upon shell-fish, and live under shelters composed of bushes.

For the development of Queensland the one great desideratum is the storage of water in connection with every industry. Although great progress has been made during late years in the construction of railways for this purpose, yet much remains to be done in this particular to develop the mineral wealth of the interior, particularly the Cloncurry district, where we found abundance of copper.

With reference to the Kanakas, we saw numbers of them in the neighbourhood of Maryborough, and all were well fed and clothed. Upon one plantation I visited their dwellings, and found them better housed than the men on the squatters' stations. I wish all the labourers at home were as comfortably situated.

With regard to fever and ague, I can only say that I experienced neither, although I was attacked by both in East India, and also in Central America. Indeed, the dry salubrious climate of the plains, which much reminded me of the Argentine Republic, would certainly not seem to be conducive to either.

JOHN ROBINSON, M.Inst.C.E.

Wathfield, Kendal, Westmoreland.

General Notes.

PARIS CONGRESS OF "ISTITUTIONS DE PREVOYANCE."—Information has been received from the Foreign-office, through the Science and Art Department, that the Second Quinquennial Session of the Universal Scientific Congress of "Institutions de Prévoyance" will be held at Paris, from the 9th to the 15th July. The President is Mons. Leon Say, and the General Secretary, Mons. A. de Malarie, 68 Rue de Babylone, Paris.

PAPER MILLS IN THE WORLD.—It appears from statistics that there are in the world no less than 3,985 paper-mills, producing yearly 959,000 tons of paper made from all kinds of substances, including rags, straw, and alfa. About one-half the quantity is printed upon; and of these 476,000 tons, about 300,000 tons are used by newspapers. The various Governments consume in official business, 100,000 tons; schools, 90,000 tons; commerce, 120,000 tons; industry, 90,000 tons; and private correspondence another 90,000 tons. The paper trade employs 192,000 hands, including women and children.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 25...Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m.
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Annual Meeting.

TUESDAY, JUNE 26...Statistical, Somerset-house-terrace, Strand, W.C., 4 p.m. Annual Meeting.
Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. R. B. White, "Notes upon the Aboriginal Races of the North Western Provinces of South America." 2. J. Park Harrison, "On the Relative Length of the First Three Toes of the Human Foot." 3. Mr. Worthington G. Smith, "Palæolithic Implements from Leyton and Walthamstow, London."

WEDNESDAY, JUNE 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. Annual General Meeting.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Mr. Robert N. Cust, "Algeria, Tunisia, and the Sahâra."
East India Association, the Lower-hall, Exeter-hall, Strand, W.C., 2½ p.m. Adjourned Meeting on the Paper read by Mr. Robert H. Elliot, "Is the Attempt to Pass the Criminal Jurisdiction Bill Calculated to Promote the Public Interests and Welfare of the Inhabitants of India generally?"

THURSDAY, JUNE 28...Antiquaries, Burlington-house, W., 8½ p.m.
Society for the Encouragement of Fine Arts, 9, Conduit-street, W. Morning Meeting.

FRIDAY, JUNE 29...Aeronautical Society (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. General Meeting.
Royal United Service Institute, Whitehall-yard, S.W., 3 p.m.

Journal of the Society of Arts.

No. 1,597. Vol. XXXII.

FRIDAY, JUNE 29, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

POSTPONEMENT OF THE CONVERSAZIONE.

It has been found necessary to alter the date of the Conversazione from the 11th to the 25th July.

It will be held, as previously announced, at the Fisheries Exhibition, South Kensington, and their Royal Highnesses the Prince and Princess of Wales will be present.

The members' Invitation Cards will be sent out shortly. The alteration in the arrangements will, of necessity, cause a slight delay in their issue.

Proceedings of the Society.

ANNUAL GENERAL MEETING.

The Annual General Meeting for receiving the report from the Council, and the Treasurer's Statement of Receipts, Payments, and Expenditure during the past year, and also for the Election of Officers, was held, in accordance with the Bye-laws, on Wednesday last, the 27th of June, at 4 p.m., Sir William Siemens, D.C.L., LL.D., F.R.S., in the chair.

The Secretary read the notice convening the meeting, and the minutes of the previous annual general meeting.

The following candidates were proposed, balloted for, and duly elected members of the Society:—

Alley, Stephen, 15, Royal-crescent, Crosshill, Glasgow.

Attock, Frederick, Somerset-house, Newton-heath, Manchester.

Barber, Edward, 88, Fishergate-hill, Preston, Lancashire.

Barrie, Robert, 16, Tavistock-street, Covent-garden, W.C.

Barwell, William, Brookfields, Birmingham.

Bayliss, George Reginald, Spondon, Derbyshire.

Bellingham, William, 2, Edinburgh-mansions, Victoria-street, S.W.

Brewer, William John, 79, Queen-street, Cheapside, E.C.

Browning, George Frederick, The Châlet, Kingswood-road, Dulwich-wood-park, S.E.

Capell, Rev. George M., Passenham Rectory, Stony Stratford.

Clifford, Sir Charles, Hatherton-hall, Cannock, Staffordshire.

Coffin, Dr. Walter H., 94, Cornwall-gardens, S.W., and Junior Athenæum Club, W.

Connon, John Wreghitt, 23, Park-row, Leeds.

Croft, James A., Ashley, Putney, S.W.

Davies, Edward, J.P., Llwynderw, Llandinam, Montgomeryshire.

De Ferranti, Sebastian Ziani, 24, Richmond-gardens, Shepherd's-bush, W.

De Ricci, James H., Meadowbank, Twickenham.

Douglas, General C., R.A., Ruthven, The Boltons, S.W.

Eden, Hon. Sir Ashley, K.C.S.I., 31, Sackville-street, Piccadilly, W.

Elles, Colonel William K., C.B. 34, Victoria-road, Kensington, W.

Elliott, Archibald Campbell, Bogend, Symington, Kilmarnock.

Farnan, Francis, 16, Tredegar-place, Bow, E.

Fischer, Carl August, St. David's, Saltney, near Chester.

Fitch, William Bowers, New Cross Glass Works, Glenville-grove, Mornington-road, Deptford, S.E.

Fletcher, Charles Edward, Kenward, Yalding, Kent, and Union Club, Trafalgar-square, S.W.

Fletcher, George, Poplar Iron Works, Poplar, E.

Fyers, Lieut.-General William Augustus, 19, Onslow-gardens, S.W.

Gardner, C. F., 2, Farquhar-terrace, Upper Norwood, S.E.

Gerner, Captain Henry, 47, Talbot-road, Bayswater, W.

Harris, H. Graham, 5, Great George-street, S.W.

Hedley, Ernest Hall, Gelly-gron, Pontardawe, Swansea.

Holland, Alfred Robert, The Grand Hotel, Charing-cross, S.W.

Horsfield, William Joseph, Falcon-road, Clapham-junction, S.W.

Keatinge, Colonel R. H., V.C., 147, Cromwell-road, S.W.

Lane, Harry, 200, Commercial-road, Landport, Portsmouth.
McEacharn, Malcolm Donald, 6, Fenchurch-street, E.C.
Malcolm, William Rolle, 1, Hereford-gardens, Park-lane, W., and 59, Strand, W.C.
Mills, Frederick Charles, 106, Jermyn-street, S.W.
Mond, Ludwig, F.C.S., Winnington-hall, Northwich.
Morrish, T. Buxton, Leonard-house, Upper Tulse-hill, S.W., and 5, Regent-street, Pall-mall, S.W.
O'Gorman Mahon, Colonel James (*The O'Gorman Mahon*) M.A., M.P., Ennis, Co. Clare, Ireland, and House of Commons, S.W.
Pedder, W. G., India-office, S.W.
Pro[illegible], Richard Thomas, Howton, Bushey-heath, Hertfordshire.
Reed, Charles Holloway, J.P., Trimdon Iron Works, Sunderland.
Rowell, William A., Heworth Chemical Works, Gateshead-on-Tyne.
Rutherford, George, India-office, S.W.
Seton-Karr, Walter Scott, 67, Lowndes-square, S.W., and Bramshott, Farnborough, Hants.
Southwood, William, Blackheath, S.E.
Steel, Major-General James Anthony, 28, Stafford-terrace, Kensington, W., and East India United Service Club, S.W.
Sykes, Frank James, 20, Fitzroy-square, W.
Sykes, Harry Tatton, 280, Regent-street, W.
Sykes, Mrs. Mary Eflat, 20, Fitzroy-square, W.
Taylor, William, 15, Beaconsfield-road, West-green-road, Tottenham.
Vickers, James Muschamp, Mitcham-grove, Mitcham, Surrey.
Vivian, Sir Henry Hussey, Bart., M.P., 27, Belgrave-square, S.W.
Wade-Browne, Captain Edward P., 28, Ashburn-place, South Kensington, S.W.
Wardle-Bulcock, John, 11, New Market street, Blackburn, and Clitheroe, Lancashire.
Watt, John, The Maples, Kidbrooke, S.E.
Wavish, James, 34, Hamfrith-road, Romford-road, Stratford, E.

The CHAIRMAN nominated Dr. Mann and Mr. Liggins scrutineers, and before declaring the ballot open, referred to the sad news of the death that morning of Mr. William Spottiswoode, who was on the balloting list for election as a Vice-President of the Society. His death was not only a great loss to the Society of Arts, but to science generally; for, as President of the Royal Society, he had won the esteem and admiration of everyone with whom he had been associated. The Chairman added that it had been thought well to leave the balloting list unaltered.

The SECRETARY then read the following—

REPORT OF THE COUNCIL.

I.—ORDINARY MEETINGS.

In accordance with the usual practice, the Session commenced with an address from the Chairman of the Council, Dr. (now Sir William) Siemens. Sir William Siemens devoted his address to the consideration of the present condition of electric lighting, and illustrated his remarks by a very clear statement of the cost and plant which would be required to light a certain definite area in the metropolis. The practical form in which these suggestions were made, and the weight that is, of course, attached to any opinion offered on electrical subjects by Sir William Siemens, caused a good deal of public attention to be given to the address, and it may be said to have proved a most valuable contribution towards the solution of a very difficult question. The subject of the practical applications of electricity, as it formed, both in this and last Session, the chief topic of the chairman's address, so in both Sessions several of the papers read at the ordinary meetings were devoted to it. That the members are by no means tired of the discussion of this important subject is plainly shown by the crowded and attentive audiences which have attended the reading of the various electrical papers. The first of these papers was by Mr. W. H. Preece, on "Electrical Exhibitions." Mr. Preece, to whom the Society has been greatly indebted, in this and previous Sessions, for many valuable papers and lectures, traced the effect which the various Exhibitions, since the first great one of 1851, have had in educating the public to a knowledge of electrical matters. Later on in the Session, Mr. J. N. Shoolbred, in his paper on the "Measurement of Electricity," gave an account of the various forms of apparatus which have been devised by electricians, in order to measure the commodity which they hope soon to be supplying to the public in the same way as gas is supplied. In the following week, two most important papers, the joint production of Mr. Alexander Siemens and Dr. E. Hopkinson, were read. The first dealt generally with the question of transmitting power by electricity, and the second with the special instance of such an application in the railway now at work in the north of Ireland. The excellent paper read, two years ago, by Mr. Alexander Siemens, upon "Electrical Railways," explained the principles on which such

railways would be worked, and told what electricians hoped to be able to accomplish. In the papers read last April, the authors were able to point to several examples of such railways actually at work. The same subject was treated, a few weeks later, by Professor George Forbes, in his paper on "Electricity as a Motive Power." Professor Forbes showed very clearly the point which has now been reached in the attempt to utilise electricity for mechanical purposes, and endeavoured also to point out what further progress might be expected in the immediate future.

During recent years, not a very great amount of attention has been paid to agricultural questions; but in the Session just passed they have received unusually full discussion. Mr. Pidgeon, under the title of "Recent Improvements in Agricultural Machinery," gave a full and exhaustive history of the progress which has been made, during some years past, in the application of machinery to agricultural purposes. During the earlier part of the Session, Mr. W. A. Gibbs, who is well known for the attention he has devoted to the subject, and who, in 1868, received a gold medal from the Society for an essay upon it, gave an account of the different systems now advocated for the artificial drying of crops; and, some weeks later on, Professor Thorold Rogers gave the Society an account of the new practice for preserving fodder which is practised in the United States, and known as ensilage. This paper, and the discussion upon it, will have done considerable good in drawing the attention of the farmers and others to the process, and many of those who were present undertook to make experiments during the present season, so that the practical value of the plan may be fully tested.

Turning to another subject, which has of late years occupied much of the attention of the Society—sanitation—we find that two papers were read, one by Mr. W. K. Burton, who gave an account of the method which experience has proved to be the best of testing the sanitary condition of houses; while Captain Galton dealt more largely with the whole question in his paper on the "Economy of Sanitation."

One of the principal points to which the Council, during the past two Sessions, have been devoting their attention, is the reform of the Patent-law. Besides working at the matter in Council and in Committee, they thought it well that the members generally, and others interested in the question, should have an opportunity of discussing both the Bill of the Society of Arts and the measure introduced on behalf of the Government by Mr. Chamberlain. The former opportunity was provided by the reading of a paper, by Sir Frederick Bramwell, on the Society of Arts' Patent Bill; while the latter was afforded by the paper read by Mr. H. Trueman Wood, the Secretary of the Society, after the second reading of the Government Bill in the House of Commons. Both these papers gave rise to long and valuable discussions—that on Mr. Wood's paper extending over two evenings. The remarks made in these discussions were of great value, as informing members of the House as to the views taken by experts on this difficult question.

Of papers dealing with the practical application of the fine arts we have had several, all of them of a very high character. Mr. Seymour Haden, at the last meeting of the Session, vigorously put forward the claims of etching, as an original art, to rank above line-engraving, which he condemned as being the mere work of the copyist. Mr. Wilfred Cripps contributed a valuable paper on English and foreign silver work. Mr. Cripps has been acting as the adviser of the Science and Art Department, in selecting examples from foreign collections for reproduction, with a view to their being exhibited in the South Kensington Museum, and also being lent to provincial museums. The paper was well illustrated by a magnificent collection of these reproductions, kindly lent for the occasion by the South Kensington authorities. Some remarks of Mr. Cripps on hall-marking provoked an animated discussion as to the relative advantages and disadvantages of the practice. The third paper which may be included in this class, was that of Mr. Hipkins, on the history of the pianoforte. Mr. Hipkins is well known as a great authority on this subject, and the Society was fortunate in being the means of publishing the result of many of the investigations to which he has devoted his life.

The question of collisions at sea, which is now being considered by a Committee of the Council, was brought before the Society by Captain Colomb, in a paper similar to the one he read last year, at Southampton, before the British Association. This paper, which was read near the beginning of the Session, produced a two nights' discussion, and was a valuable contribution to a subject which was, unfortunately, brought vividly before the public mind by the disastrous collisions which occurred during the past winter.

The subject of Technical Education, in which the Society feels as keen an interest as ever—although the work which it had at one time to carry on, almost single-handed, is now more ably dealt with by the powerful institution which has been founded by the London Livery Companies—formed the subject of a paper by Mr. Magnus. Mr. Magnus's position as Director of the City and Guilds Institute, and as one of the Royal Commission on Technical Education, enabled him to bring specially valuable information before the Society; and his paper on "Technical Instruction in Elementary and Intermediate Schools," though dealing with a subject which has been greatly written upon of late, was full of novel and suggestive views.

Another valuable paper, on a subject which has been fully discussed elsewhere, was that by General Rundall upon the Suez Canal. General Rundall succeeded in embodying in his remarks much useful information, and many practical suggestions of importance. Dr. John Hopkinson, in his paper on "Ice-making and Refrigerating," gave an account of some of the more recent inventions intended for the manufacture of ice, or the production of cold. Mr. Simmonds dealt, not for the first time before the Society of Arts, with a subject which he has made his own, the utilisation of waste. Mr. J. H. Evans gave an account of the modern lathe as applied to ornamental turning. Mr. J. C. Bloomfield, the originator of the Belleek Pottery, in a paper on the development of Irish industries, advocated the establishment of similar industrial centres in Ireland; and Mr. Cornelius Walford directed the attention of the Society to the increasing destruction of life and property by fire, suggesting as a remedy the adoption of a system of inquiry in all cases where considerable losses of property had occurred without loss of life.

II.—Indian Section.

The five papers which were read in the Indian Section were all of them extremely good, and, indeed, may be said even to have been above the very high average attained by the papers in this Section last year. The meetings were well attended.

The first paper was on "The Overland Route towards China, *viâ* Assam, from India," by Mr. Charles H. Lepper, who spoke of it from personal acquaintance with, and experience of, that border country and its people. He proposed to open up friendly communication on neutral border ground, with the view of not only providing a market hitherto quite inaccessible for our goods, but also a basis of access to the enterprising Chinese labourers to Assam, where labour is so much needed by our tea planters. Mr. Lepper's paper was followed by one on "Agriculture in Lower Bengal," by Mr. W. S. Seton-Karr, who gave a most interesting and graphic account of the system of cultivation pursued in that province, the different crops raised, and the native cultivator. The third paper was by Mr. W. G. Pedder, of the India-office, on "The Historical Development of the Different Land Settlements in India." It was a most able and comprehensive summary of the history of the changes, at different periods, in the principal systems of the assessments on land prevailing in the different provinces of that country. In his paper on the "Fisheries of India," Surgeon-General Francis Day gave an interesting account of the edible Indian fish, of the present systems of fishery, of fish-curing, the hindrances, under existing circumstances, affecting this very important industry, and suggestions for improvements in legislation affecting it. Dr. Day has had the arrangement of the Indian Branch in the Fisheries Exhibition now open at South Kensington. At the last meeting of the Section, Mr. C. Purdon Clarke read a paper which he modestly entitled "Notes on Domestic Architecture in India." It treated of an almost untouched subject in a most interesting and instructive way, and was copiously illustrated by models, plans, drawings, and photographs.

III.—Foreign and Colonial Section.

The meetings of the Foreign and Colonial Section were, as usual, six in number, and some interesting and important subjects have been brought under the consideration of the Society at them. Mr. Edmond O'Donovan, at the first meeting, gave an account of his visit to the Turcoman Nomads and Merv in 1879, and called attention to the rapid movement of Russian enterprise in the direction of Herat. The Rev. J. Peill gave an interesting report of the present state of Madagascar, and of the remarkable advance of the Hovas in the arts of civilisation, which was strikingly confirmed by Vice-Admiral Gore Jones, speaking of his own observations upon the occasion of his recent special mission to Queen Ranavalona. This communication derived an additional interest from the presence of the

Malagassy Ambassadors in England at the time. Mr. R. W. Felkin, in a paper on "Egypt: Present and to Come," advocated increased facilities for communication and trade with the Equatorial Provinces and the Soudan, and the establishment of a railway between Souakim, on the Red Sea, and Berber, on the Nile. Mr. W. Delisle Hay, in referring to the social and commercial aspects of New Zealand, gave a detailed sketch of the principal settlements already opened out upon the Islands. Colonel Bateman-Champain furnished an admirable supplement to Mr. O'Donovan's allusion to the Merv District, in his remarks upon the trade routes of Persia, and the desirability of opening a new route for British trade by the Persian Gulf and the River Karun, as a set-off against Russian enterprise, so vigorously pushed by the Volga and the Caspian. The last paper contributed to the Section was an account, by Mr. Arthur J. Stanesby, of the industries and enterprise of Queensland, with an explanation of the particular plan of land settlement so successfully established by its Government, a plan which appears to have been one of the chief sources of the rapid and steady progress of the colony.

IV.—Applied Chemistry and Physics Section.

The meetings of this Section commenced after Christmas with a paper by Mr. C. F. Cross, on "The Technical Aspects of Lignification." His paper described recent processes for the conversion of woody fibre into textile fabrics. At the second meeting, Mr. W. G. McMillan dealt with a subject which is always one of great public interest, the causes and prevention of fires. The careful and elaborate statistics which Mr. McMillan had collected, and the way in which they were arranged, added greatly to the value of this paper. The next paper was by Mr. W. N. Hartley, on the "Self-purification of Peaty Rivers." Mr. Hartley vigorously opposed the theory put forward by Dr. Tidy and others, that the water of such rivers is purified by a process of oxidation, and argued that the purification was really effected by contact with the materials of which the river bed is formed. Mr. Hartley did not apply his theory to sewage pollution, though a reference to this subject made at the close of his paper left very little doubt that he would be disposed to extend his argument to this, naturally by far the most important portion of the question. Mr. Atkinson, in his paper on "The Formation of Diastase from Grain by Moulds," gave an account of the curious brewing system adopted in Japan, and described fully the preparation of the substance kôji, which corresponds to our English malt. Mr. Atkinson also gave important tables dealing with the action of this kôji on starch, and with the mash at different dates during the process of brewing. Mr. Lightfoot, in describing Jameson's process for recovering the gaseous products from coke-ovens, also threw out several suggestions as to the utilisation of coke and gas for domestic and other purposes, and the discussion turned to some extent upon the application of such processes to the prevention of smoke in large towns. The last paper of the Session in this Section was by Mr. J. H. Gordon, on the development of electric lighting. In it Mr. Gordon explained to the Society the principles on which he himself had been working in constructing dynamos of very large size, running at a moderate speed.

V.—Cantor Lectures.

During the present Session, there have been five courses of Cantor Lectures. Those which attracted the largest audiences were the first and the last courses, dealing, as they did, with the ever attractive subject of electricity. The first was by Professor Silvanus Thompson, who, in a course of three lectures, gave an account of the dynamo machine; while the last was by Professor Oliver Lodge, who devoted two lectures to the subject of "Secondary Batteries." The second course was on "Solid and Liquid Illuminating Agents," by Mr. Leopold Field. In former courses the subjects of illumination by gas and by electricity have been fully dealt with, and Mr. Field's lectures were specially valuable as giving an account of the older methods of illumination. The care which he bestowed upon them, and the lavish way in which his connection with the firm of Messrs J. C. and J. Field enabled him to illustrate his lectures, caused them to be fully appreciated by the numerous audiences which attended them. The third course was on "The Decorative Treatment of Metal in Architecture," by Mr. Birch, who dealt both with the historical and practical sides of the question; while the fourth was on "The Transmission of Energy," by Professor Osborne Reynolds. Professor Reynolds dealt for the most part with theoretical considerations, and with the methods of storing and conveying energy other than electrical.

VI.—Juvenile Lectures.

The usual short course of juvenile lectures was delivered, during the Christmas holidays, by Professor H. N. Moseley, the subject being "The Inhabitants of the Ocean." Mr. Moseley took the *Challenger* expedition for his text. His first lecture dealt with life on the surface of the ocean, and his second with what is known of life at the bottom of the sea. Both lectures were fully illustrated by a very fine series of lantern slides of the different animals described.

VII.—Albert Medal.

The Albert Medal for the present year has been awarded to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.I., LL.D., F.R.S., for "the eminent services which, as a botanist, as a scientific traveller, and as Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce, by promoting an accurate knowledge of the floras and economic vegetable products of the several colonies and dependencies of the Empire." In making this award the committee have endeavoured to recognise services of a somewhat different character from those which, in recent years, have been marked by the award of the medal. The labours of Sir Joseph Hooker, in disseminating a knowledge of vegetable products useful to man, and in encouraging the cultivation of those products in the different countries of the world, have long been known, not only to men of science, but to those engaged in commerce and industry. It is, of course, not the object of the Albert Medal to recognise scientific merit, however great, and the Council believe that in making the award which they have made, they have added to their list the name of yet another eminent man of science who has so directed his labours that they have borne practical fruit.

VIII.—Medals.

The Council have awarded nine Silver Medals to the authors of papers read during the past Session. Of these, five have been for papers read at the Ordinary Meetings, two for papers read in the Indian Section, and two for papers read in the Foreign and Colonial Section. The Council have always considered it undesirable that they should award medals to any members of their own body, and they have extended this rule so as to make it apply also to the Secretary. Amongst the papers read during the past Session there were three, the importance of which they were, therefore, precluded from recognising otherwise than by a vote of thanks. The papers in this category were by

Sir Frederick Bramwell, F.R.S., Vice-President of the Society, on "The Society of Arts Patent Bill, and some Points in American Patent Law and Practice bearing thereon."

W. H. Preece, F.R.S., Member of Council, on "Electrical Exhibitions."

H. Trueman Wood, B.A., Secretary of the Society, on "The Government Patent Bill."

The following is a complete list of the awards :—

To D. Pidgeon, for his paper on "Recent Improvements in Agricultural Machinery."

To A. J. Hipkins, for his paper on "The History of the Pianoforte."

To Alexander Siemens and Edward Hopkinson, D.Sc., for their papers—I. "The Transmission of Power by Electricity." II. "The Portrush Electrical Railway."

To Captain Douglas Galton, C.B., F.R.S., for his paper on "Economy of Sanitation."

To F. Seymour Haden, F.R.C.S., for his paper on "The Relative Claims of Etching and Engraving to Rank as Fine Arts."

To Edmond O'Donovan, for his paper on "Life Among the Turcoman Nomads."

To Colonel Bateman Champain, R.E., for his paper on "The Trade Routes of Persia."

To W. S. Seton-Karr, for his paper on "Agriculture in Lower Bengal."

To W. G. Pedder, for his paper on "Historical Development of the Different Settlement Systems of British India."

IX.—Patent Law.

It was stated in the last Report of the Council that a Bill, prepared by a Committee of the Council, had been introduced in the House of Commons, on behalf of the Society, by Sir John Lubbock, Mr. W. H. Smith, and Mr. J. C. Lawrance, and after being read a second time, had been dropped. After full consideration, the Council came to the conclusion that the Bill should be introduced again this Session in the same form, and the same members kindly undertook the duty of doing so. The Bill was read a first time on the 19th of February, and a second time on the 27th of February. Amongst the measures announced in the Queen's Speech was one for the reform of the Patent Law. This Bill, which indeed had been expected in the previous Session, was brought in by Mr. Chamberlain on behalf

of the Government, and after being read a first time on the 19th of February, was read a second time on the 16th of April. The Government Bill was at once referred to the Standing Committee on Trade, and it was announced that it would be taken up by that Committee as soon as the Bankruptcy Bill, which preceded it, had been disposed of. The progress, however, which the Committee made with the Bankruptcy Bill proved to be very much slower than was expected, and the Patent Bill has not been taken in hand by the Committee. It became a point for consideration of the Council whether they should endeavour to get the Society's Bill referred to the same committee, but on consideration it appeared that little would be gained by this course of proceeding, and accordingly no attempt was made to proceed with the Society's Bill, pending the fate of that promoted by the Government. The Committee have even thought it well to take in hand the preparation of a series of amendments to various clauses of the Government Bill, which might be brought forward in committee, in the hope of bringing the Government measure more into harmony than it at present appears to be with the views, not only of the Society's committee, but of many other authorities on the subject of patent-law. As stated in a previous part of the report, several evenings have been devoted to the discussion both of the Society's Bill and that of the Government. In one paper, Sir Frederick Bramwell gave the results of a recent visit to the United States, and of some inquiries he had made into the American patent-law practice. Sir Frederick showed how this practice bore upon the reforms proposed in the Society's Bill, and brought forward many arguments in favour of the Society of Arts' scheme. A paper was also read by Mr. H. Trueman Wood, the Secretary of the Society, on the Government Bill. This paper, as it happened, almost coincided with the second reading of the Bill, and gave rise to very considerable discussion. In the discussion the remarks of Mr. Webster, who presided, were of the utmost value, and it is satisfactory to be able to record that in his opinion, as well as in that of several other speakers, there were very many points in which the Society of Arts' measure was superior to that of the Government. The objections to certain points of the Bill, pointed out in the paper, were confirmed by the opinion of many of those who took part in the discussion. The announcement has been made that the Government intend to persevere with their Bill, but even now it is hardly possible to predict what the event will be. It is, perhaps, only the more sanguine who have any very strong hope that the long promised reform in the Patent-law will not be deferred, at all events, for one more year. Should it be necessary to continue, during another Session, the efforts which the Council, on behalf of the Society, have made towards Patent-law reform, the members may rest assured that those efforts will not be wanting.

X.—Fires in Theatres.

On the suggestion of Mr. T. V. Lister, the Council appointed a Committee to consider the question of fires in theatres, and the best means of preventing them. After several meetings, this Committee presented a Report to the Council, which summarised the most important suggestions which had been made from time to time, as to the measures required for effecting this object, the report being supplemented by appendixes containing a good deal of information not hitherto made public, as to the researches carried on by the War-office upon various agents intended to reduce the inflammability of materials and fabrics used in construction. This Report was presented to a public meeting, held on the 31st of May last, and elicited a discussion in which valuable information was given, by members of the Society and others who attended. The proceedings of the meeting terminated by the passing of three resolutions. The first of these dealt with the unsatisfactory nature of the present system for the regulation of theatres; the second was intended to impress upon theatrical managers the necessity for devoting further attention to the various methods for reducing the inflammability of materials; while the third advocated the holding of an official inquiry in cases where loss of property, without loss of life, has occurred from fire. The Council are now taking steps to draw the attention of the Government to these resolutions.

XI.—Collisions at Sea

A Committee of the Council is now sitting to consider whether any recommendations, having for their object the reduction of the many disastrous losses from this cause, could be made to the Board of Trade. In answer to a published announcement, the Committee have received a great number of suggestions from inventors and others who have given attention

to the subject, and they hope before very long to be able to publish a report.

XII.—Education in Forestry.

It was stated in last year's Report that the Council had appointed a Committee to consider the question of education in forestry, with a view to the attention of Government being drawn to the desirability of providing means by which suitable instruction in the science of forestry might be given in this country, instead of the engineers required for forest conservancy in India and elsewhere being sent to foreign schools, at the cost of the Government. In June last, at the first meeting of Council after the Annual General Meeting, at which the Report was read, a memorial on this question was adopted, and transmitted to the Secretary of State for India. The memorial, a copy of which appeared in the *Journal* for July 14th, 1882, impressed upon the Indian Government the necessity for the establishment of a department for the teaching of forestry in the Royal Engineering College, at Cooper's-hill. The Council are glad to be able to report that the memorial was favourably received, and that, though certain departmental considerations prevented any steps being taken at the time to carry its suggestions into practice, the Council have every hope that, before long, their recommendations will be acted upon.

XIII.—Premiums.

Of the premiums which are offered from funds specially held in hand for the purpose, six have been offered for the present year. These are the John Stock, Benjamin Shaw, Howard, Fothergill, Mulready, and Owen Jones. The John Stock Trust dates back to 1781, and various prizes have been awarded under it. A gold medal is now offered for the best design for mural decoration. The Benjamin Shaw Trust dates only from 1876. It was founded by Mr. Shaw during his lifetime, and was intended to promote improvements in industrial hygiene. The award is a quinquennial one, but as it was not made when it was first offered in 1877, the Council have determined to offer two gold medals during the present year, one for methods of diminishing risk in coal-mining, and the other for diminishing risk in manufacturing and storing explosives. Since this offer was made, the public attention has been, unfortunately, very much directed to the manufacture of explosives, and the selection is perhaps even more opportune than it was when first announced. The Howard prize has been awarded in former years, and under this trust a prize of £100 is now offered for the best essay on the utilisation of electricity for motive power. The Fothergill prize is also one of long standing (1821). It is now offered for the best invention having for its object the prevention or extinction of fires in theatres. No prize has ever been offered under the Mulready Trust before, sufficient accumulation not having previously accrued. The amount is only £109, and is subject to certain small charges for repairing the monument to Mulready in Kensal-green Cemetery. The Owen Jones prize is awarded annually, and is offered this year under the usual conditions. Besides these, the Society hold the following trust funds:—Swiney, under which an award for a treatise on jurisprudence is made every five years. North London Exhibition.—The surplus from the North London Exhibition, held in 1864, was presented by the trustees to the Society, with the intention that the interest should be awarded annually in prizes at the Art Workmen's Exhibitions of the Society. These Exhibitions ceased in 1871, and only one has since been held, that in the Albert-hall, in 1881. The amount therefore accumulated, namely £34 15s. has been invested and added to the principal, pending the offer by the Society of prizes which would come within the conditions of the trust. Aldred.—This was a bequest of £90, in 1868, the interest to provide a £5 prize annually for an essay on a literary or scientific subject. Inasmuch as the interest on £90 is not sufficient to provide the required amount, the interest has been allowed to accumulate until the necessary sum, £166 13s. 4d., has accrued. Trevelyan.—A sum of £100, presented to the Society by the late Sir Walter Trevelyan for prizes, has been offered frequently, for a method of preserving fresh meat, this being an object which it was known the donor had at heart. It, however, has never been awarded, and the Council will hereafter consider what other offer might most usefully be made with this money. The only other funds of the nature of trust funds held by the Society of Arts are the Cantor bequest, £5,052, in 1861, and the Alfred Davis bequest, £1,800, in 1870, both of which are entirely unfettered. The former, as members will be well aware, is used in providing the Cantor Lectures.

XIV.—Miners' Safety Lamp.

A prize of £500 was offered by Mr. Ellis Lever for a new miners' safety lamp, and Mr. Lever requested the Society to appoint one of the judges to award the prize. In accordance with this request, the Council appointed Sir Frederick Abel. The competing lamps are to be submitted to the judges at the end of the present year. Full particulars of the conditions will be found in the *Journal* for the 30th of March last.

XV.—Plant Label.

In 1881, Mr. G. F. Wilson offered, through the Society, a prize of £5 for the best plant label. The labels sent in, in the first instance, were none of them considered worthy of the prize, which was accordingly offered a second time. From the labels sent in in response to this second invitation, the Committee selected the one sent by Mr. Alment as the best, and the £5 prize was accordingly awarded to it. Mr. Wilson then renewed his offer, but confined it to a wooden label, treated with some preservative preparation; and Mr. E. G. Loder offered an additional prize of £5 5s. for the best permanent border-label, suitable for private gardens. In response to these offers a number of labels were received at the appointed date, the 1st of June last, and these are now under the consideration of the Committee.

XVI.—Swiney Prize.

This prize will be awarded in January next, as it becomes due every fifth anniversary of the testator's death. Dr. Swiney died in 1844, and in his will he left the sum of £5,000 Consols to the Society of Arts, for the purpose of presenting a prize to the author of the best published work on Jurisprudence. The prize is a cup value £100, and money to the same amount; the award is made jointly by the Society of Arts and the College of Physicians. The cup now given is made after a design specially prepared in 1849 for the first award, by D. Maclise, R.A. The following is a list of recipients:—

1849. J. A. Paris, M.D., and J. Fonblanque, for their work, "Medical Jurisprudence."
1854. Leone Levi, for his work on "The Commercial Law of the World."
1859. Dr. Alfred Swayne Taylor, F.R.S., for his work on "Medical Jurisprudence."
1864. Henry Summer Maine (now K.C.B.), D.C.L., member of the Legislative Council of India, for his work on "Ancient Law."
1869. William Augustus Guy, M.D., for his "Principles of Forensic Medicine."
1874. The Right Hon. Sir Robert Joseph Phillimore, D.C.L., for his "Commentaries on International Law."
1879. Dr. Norman Chevers, for his "Manual of Medical Jurisprudence for India."

XVII.—Owen Jones' Prizes.

These prizes are provided by the interest on the sum of £400, presented to the Society of Arts by the Owen Jones Memorial Committee to students of the Schools of Art, who produce the best designs for household furniture, &c., on the principles laid down by Owen Jones. The prizes are awarded on the results of the annual competition of the Science and Art Department. Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design" and a Bronze Medal. A list of the successful candidates has appeared in the *Journal*.

XVIII.—Examinations.

The scheme of Examinations which was tried for the first time last year, has been continued with hardly any alteration during the present year, and with extremely satisfactory results. It will be remembered that last Session the Council, in answer to an application from many of the Institutions in Union, determined to resume the Commercial Examinations, discontinued after 1880. Some modifications were made in the former system, the principal one being that a fee of 2s. 6d. was charged to each candidate. Last year this rule was not applied to the subjects Political Economy, Domestic Economy, Health, and Theory of Music; the examination in these subjects not having been discontinued, and the usual announcement having been made with regard to them. In the programme issued for 1883, there were no alterations of any consequence, except that all the subjects were brought into the same category as regards fees. Also the three subjects, Clothing, Cookery, and House-keeping were, in accordance with a suggestion emanating from one of the institutions, formed this year into a single subject, under the head of Domestic Economy. The Examination in Health was continued under the title of Sanitary Knowledge. Last year prizes were given in the special subjects before mentioned; this year there were no prizes in any subject. Certificates were given in three

classes instead of two, and the restriction as to the age of candidates was removed. It may also be noted that the examinations were held independently, instead of, as last year, in connection with the examinations of the Science and Art Department, it having been ascertained that this would be most convenient, by means of an inquiry circulated to the institutions. The number of candidates, although very much less than the number which entered during the last year in which the examinations were free (1880), is certainly such as to justify the alterations. It may be sufficient here to draw attention to a few significant figures. The total of papers worked was 845. Last year 695 were worked; in 1880, 2,325. There is, of course, as was expected, a considerable decrease in the number of candidates in the subjects which were free last year. There were 45 papers worked this year in Domestic Economy, whereas last year there were 137. Inasmuch, however, as there were three papers last year, the same candidate often took up more than one of the sub-divisions, and was therefore counted twice. In the Theory of Music there were last year, when no fees were charged in this subject, 268 candidates; whereas this year there are 195. Nearly all the other subjects show a large increase. In shorthand, the large number of 201 candidates presented themselves, as against 27 last year; but the proportion of failures in this subject is very high—viz., 103. Book-keeping, with 141 candidates, as against 39 last year, shows a very large increase. There is little doubt that the fee, while serving to make the examinations to a large extent self-supporting, has weeded out the inferior class of candidates, without, to any considerable extent, deterring the better class from presenting themselves. The Council have decided not to make any alterations of importance in the programme for 1884, which will be issued very shortly.

XIX.—Practical Music Examinations.

Practical examinations in Music have been held this year at two provincial centres, Liverpool and Glasgow, besides the examination in London. The London examination for 1882 was in July of that year, and that for 1883 has been held during the present month. It was thought that one in the year would be sufficient, and no examination was therefore held in January. At Liverpool, 57 candidates presented themselves, all of whom passed; 29 first class certificates were awarded, and 38 second. At Glasgow 77 candidates entered, of whom 70 passed, taking 21 first class, and 53 second. At London, in 1882, there were 177 candidates, of whom 152 passed, taking 75 first class, and 102 second class certificates, with one second class honours. In the present year's examination, 164 entered, and 160 passed, taking 61 first class and 120 second class certificates. Two candidates also took first class in honours. It is to be noted that many of the candidates were examined both in the pianoforte and singing, and consequently the number of the certificates awarded does not agree with the total number of candidates passing.

XX.—Electric Telegraphs.

In many previous reports, the efforts made by the successive Councils and Committees of this Society to reduce the present tariff for inland telegraphs have been recorded. The Council are glad to be able to congratulate the members on their efforts in this direction having at last borne fruit. It is understood that at the present moment a tariff is under consideration, the main feature of which will be the introduction of sixpenny messages, and that we may soon learn the date fixed for the introduction of this desirable reform in the cost of sending telegrams.

XXI.—Conversazione.

It has been found necessary to postpone the date of the Conversazione for the present Session, and it will be held on the evening of Wednesday, the 25th of July next. In order to provide a change from the usual arrangements, the Council availed themselves of the opportunity of the Fisheries Exhibition, to make an application to the Executive of the Exhibition for the loan of the buildings on one of the few nights when they are not to be open to the public. H.R.H., the President of the Society, on a request being made to him, graciously consented to attend, and when it became evident that to do fitting honour to the occasion, greater cost would be incurred than could, in the opinion of the Council, legitimately be defrayed from the Society's funds, their Chairman, Sir William Siemens, with great liberality, offered to take upon himself any additional cost for refreshments, music, &c., which might be incurred, if the arrangements were made on a somewhat more liberal scale than usual. It should be

added that the Society is indebted to the Executive of the Exhibition for lending the buildings without charge beyond the actual cost incurred.

XXII.—Repairs to Premises.

In the summer of last year, the Society's premises were put into a thorough state of repair. It appeared, on investigation, that a considerable amount of general repairs was required. The external stone and brickwork of both the two houses forming the Society's premises were cleaned and pointed, part of the parapet in front was rebuilt, and the roof was repaired. As regards internal repairs, the upper part of the principal staircase leading to the top of the house was found to be hardly in a safe condition, and this was repaired, and strengthened by iron girders. The houses were painted almost throughout, the decorations of the entrance hall were thoroughly cleaned, the ceiling of the library was renewed, and a new hand-rail fitted to the principal staircase. The meeting room was re-decorated throughout, as was also the anteroom; and when it is remembered that the decorations of the room had not undergone any renovation, except the cleaning which they received seven years ago, since 1863, it is evident that these steps were not taken before they were required. The seats in the meeting room were also re-covered. Important alterations were made in the arrangements for ventilating the great room. Ventilating openings were made in the roof, leading into an air chamber which was connected, by a sufficiently wide passage, to to the upper part of a shaft already existing, and extending throughout the building from the basement to the roof. In the top of the shaft a coil of hot-water pipes was fixed, and pipes from the coil led down the shaft to a furnace in the basement, the object of this arrangement being to cause an upward current which might draw off the foul air from the upper part of the room. For the admission of fresh air, existing openings in the north side of the room were utilised, and the air entering by these was caused to pass through a grating led along the side of the room below the pictures. To ensure this air being warm, hot-water pipes, communicating with the existing heating apparatus, were fixed across the mouth of the openings. This arrangement has been found to work well, and the ventilation of the meeting-room may now be considered to be in a very satisfactory condition. Another important alteration was the introduction of the electric light. As stated in the last report, the Society was presented last year with one of Messrs. Crossley's gas-engines, by certain members of Council whose names were given. Mr. T. R. Crampton, Mr. R. Rawlinson, Mr. Loftus Perkins, and Mr. Andrew Cassels also contributed towards the cost of purchasing a dynamo machine, which Messrs. Siemens Brothers were good enough to supply for the Society on very moderate terms. For the purpose of lighting the great room by electricity, forty Edison lamps were fitted in four chandeliers suspended from the roof, and three similar lamps in a lantern in the anteroom. The Council-room has also been fitted with incandescence lamps. Arrangements were also made by which the current could be employed for experimental purposes as well as for lighting the room, and these arrangements have been found very useful on several occasions during the Session. The Council have to express their appreciation of the way in which Mr. E. C. Robins, who acted as the Society's architect, superintended the work, and of the very satisfactory way in which, under his superintendence, it was carried out. The general repairs were effected by Messrs. Watson; the decorations of the meeting-room and ante-room, with some other portions of the work, were done by Messrs. Crace; Messrs. A. M. Perkins and Sons undertook the heating and ventilating arrangements; the renovation of the furniture was carried out by Messrs. Hampton and Sons, and the very elegant chandeliers for the lights provided by Messrs. Verity. The Council believe that the additional arrangements made for the comfort of the members have been fully appreciated by them, and have given every satisfaction. The cost has, of course, been considerable, but it is satisfactory to be able to remark that the whole cost has been defrayed out of the income of the past two years.

XXIII.—New Council.

In accordance with the Bye-laws, the Council have submitted to the members a ballot-sheet for the election of Vice-Presidents and Members of Council. On the balloting list there are six new names proposed as Vice-Presidents:—Andrew Cassels, B. Francis Cobb, the Duke of Westminster, K.G., Capt. Douglas Galton, C.B., Robert Rawlinson, C.B., and Lord Sudeley. The Duke of Westminster has taken an active part in the work of this, as of so many other societies. Captain Douglas Gal-

ton and Mr. Robert Rawlinson have both served on the Council for many years before, and the members will rejoice to see them once more taking a share in the executive work of the Society. Mr. B. Francis Cobb has acted for the past five years as Treasurer, and the continuous attention he has always devoted to the affairs of the Society has induced the Council to put him forward for a further term of office as Vice-President. Mr. Andrew Cassels has been moved up from the list of ordinary Members of Council. Lord Sudeley is known to take an active interest in the practical applications of science, and he is one of the British Commissioners for the Electrical Exhibition at Vienna. As ordinary members of Council, the new names proposed are R. E. Webster, Q.C., T. V. Lister, J. M. Maclean, and Admiral Ryder. Mr. R. E. Webster, the eminent Queen's Council, has more than his own claims to recommend him to the members, for his father, the late Mr. Thomas Webster, Q.C., was for very many years one of the most active members of the Society's Council, and of its governing Committees before the establishment of the Council under the Charter granted in 1847. Mr. T. Villiers Lister, one of the Permanent Under Secretaries of the Foreign-office, was the principal promoter of the Committee on Fires in Theatres. Mr. J. M. Maclean will be remembered by the members for the paper he read last year, on "The Depreciation of Silver as it affects India;" and Admiral Ryder, who retired from the Council on his appointment at Portsmouth, is now put forward for re-election upon the term of that appointment having expired. As above stated, the term of Mr. Cobb's office of treasurer has elapsed, and the Council are glad to be able to propose as his successor Mr. W. R. Malcolm, one of the members of the firm of Messrs. Coutts, who have been so long the Society's bankers.

XXIV.—Obituary.

During the past year the Society has lost many who were closely associated with its work, and also many distinguished members who, though not taking any active part in the Society's work, have supported it by their influence. Lord Otho Fitzgerald, who died in November last, had been elected for the first time on the Council last year, and it was hoped he would have been a regular attendant. Mr. Stanley Jevons, who had been a member of the Society for some years, had, in the last year of his life, accepted the office of Examiner in Political Economy for the Society, an office which he discharged during the examinations of last year only. Mr. Blashfield, Mr. Campin, Mr. C. E. Amos, General Scott, Mr. D. G. Laing, were all members of very long standing, the last-mentioned having been a member for more than fifty years. Lord Harrowby, Sir Henry Ripley, Sir W. Hutt, Sir Thomas Watson, Mr. George Critchett, and Mr. Ashton Dilke, were all distinguished men in their several walks of life, and by their deaths the Society lost members of influence and value. Captain Gill was one of those from whom the Society might have hoped much, but for his death in the disastrous expedition in which he and his distinguished colleague, Professor Palmer, perished.

XXV.—List of Members.

The number of members on the Society's list shows an increase, though a slight one. During the year 1882-3, 300 members have been removed from the list by death or resignation. During the same period, 305 have been elected. The total number of life-members, subscribing members, and institutions in union, which subscribe to the Society from their own funds, is now 3,445.

XXVI.—Finance.

The best evidence that the finances of the Society are in a sound condition is afforded by the fact that the very heavy charges for repairs, undertaken in the summer of last year, have all been defrayed out of the revenue of this and the previous year. Such charges might, of course, well be paid out of the amount accumulated by the investment of life subscriptions, and it is, indeed, for the payment of such matters that this fund is formed. The Council, however, found themselves in a position to pay them out of the revenue, and, they hope, without affecting the usual and legitimate work of the Society. That these heavy expenses have been met accounts for the fact that the cash in hand at the end of the financial year, as shown in the balance-sheet published in the last number of the *Journal*, was considerably less than that in last year's statement, being £440, as against £1,183. A clear idea of the Society's finances may be gained from the above-mentioned statement, which is published a week before the annual meeting, in accordance with one of the bye-laws. It may, however, be convenient to offer a little explanation about some

of the principal items of receipt and expenditure. Dealing first with the debtor side of the account, it will be found that the receipts from subscriptions and life compositions, this year are about the same as those for last. The amount received for dividends and interest appears to be less this year than last, but the decrease is only apparent. It arises from the fact, as shown in the two following items, that the amount of the Swiney Bequest, £4,500 Consols, was sold out during the year, for re-investment in ground-rents. By the terms of its Charter, the Society is enabled to hold an amount, not exceeding £3,000 a year, in real property, and an opportunity for making what appeared a very promising investment having offered itself, the Council thought it well to take advantage of it. The ground-rents in which the amount has been invested are on the Tyssen-Amherst estate at Hackney. They produce a revenue of £180, as against £135 from Consols, and the Council are advised that the value of the capital thus invested is likely to increase considerably. At the remote period when the ground-rents themselves fall in, the Society of Arts will, of course, have the advantage of a very largely increased income. It is evident that for bodies like the Society, having a perpetual succession, no better or safer investment can be found than such a one as has been effected with this money. It may be noted that the actual amount of ground-rents purchased was £4,590; the amount realised by the sale of the £4,540 Consols being £4,477; and the balance of £123 was made up out of the Society's own funds. This amount of £123 was the only additional investment made during the year, the usual investment of the amount of life compositions not having been made, since the money was required for the charges for repairs. The next item on this side of the account, is a small legacy of £10, which the Society received from the late Mr. Christopher Cooke, who was a member of long standing. The examination fees this year amounted to close on £300. This amount does not fairly compare with that set down on the credit side, because in the latter sum is included a large proportion of the cost of the examinations held last year. The total cost of the examinations this year is about £320, the total receipts of fees for this year's examination £220, thus leaving a balance of £100 to be defrayed by the Society. The donations towards the purchase of a gas-engine and a dynamo machine are set down on one side of the account, the cost being included in the amount charged for repairs on the other.

On the credit side, a comparison with the various items in this and former years does not show any great variation. Details as to the amount and character of the repairs and alterations, the total cost of which was £2,204, are given in the paragraph in the report devoted to that subject. The cost of printing the *Journal* shows a certain increase, due to the alteration in type, &c., commenced in the volume for 1881-82. The charges for committees are much less this year than last, £65 against £215. This may be accounted for by the cost of the preparation of the Patent Bill last year. The £85 for the Art Workmanship Exhibition includes an amount of £23 in prizes, defrayed from the interest of the North London Exhibition Trust. Particulars of this will be found in the appropriate paragraph. The charges for Mrs. Cantor's annuity will not appear in future statements, this lady having died a few months since. Turning to the statement of assets and liabilities, and comparing it with the similar statement for last year, it is at once seen that the excess of assets over liabilities appears much less now than before, being £8,558, as against £9,954. The difference is easily explained. First of all, the cash balance in the bankers' hands is much lower now than last year, owing to the charges for repairs, and, secondly, it has been considered desirable to set down as a liability the prizes offered, but not yet awarded, from the funds accumulated under the various trusts. The total from these two heads will be found equivalent to the difference between this and last year's statement. A full account of the Society's investments and trust funds is appended to the statement. On the whole, it will be seen that though at first sight the statement would appear to compare unfavourably with that submitted last year, this is really only apparent, and is due to the heavy charges which though, as above stated, they might legitimately have been charged to capital account, the Society has been able to defray out of current revenue.

The adoption of the report was moved by the CHAIRMAN, and seconded by Lord ALFRED CHURCHILL.

Mr. WILLIAM PITMAN said that he was sorry to learn from the report that in respect to some of the Society's property, Consols had been exchanged for what he considered to be speculative investments, as he held that institutions such as theirs should be contented with Government securities.

Mr. B. F. Cobb remarked that ground-rents were one of the safest and most satisfactory of investments for established societies, because, in course of time, the property would come into their own possession.

The Chairman said that other institutions with which he was connected had done exceedingly well with investments in land, which could not in any way be considered as speculative.

Mr. F. P. Ward made some remarks on the change of date for the forthcoming Conversazione.

The Chairman and Sir Philip Cunliffe-Owen explained the reasons that had necessitated this change of date.

Mr. Liggins expressed his appreciation of the great improvements which had been made in the Society's house, but suggested that some alteration should be made in the form of the seats, so that they might be more comfortable.

The report was then adopted.

The Chairman said the members were aware that no business could be transacted at the meeting without due notice; but he was sure that the members would feel with him that this rule did not apply to the resolution which he was about to propose. He then enlarged upon the severe loss which the Society, in common with the Royal Society and the scientific world at large, had suffered in the death of Mr. William Spottiswoode, and concluded by moving the following resolution, which was carried unanimously: —"That this meeting of the Society of Arts desires to express the deep regret with which it has received the news of the death of Mr. William Spottiswoode, one of its Vice-Presidents, and its sense of the loss which the Society has sustained by his decease. In him, England loses one of her most remarkable men of science, science itself one of its greatest ornaments, and all who knew him a sincere and valued friend. Besides devoting his own time and thought to the advancement of knowledge, he was ever ready to lend to all engaged in like pursuits the assistance of his experience and his wise counsel. In thus placing on record their own appreciation of his services, the Society desires to express its feelings of sympathy with his widow and his family, and also with the Fellows of the Royal Society, of which he was the honoured and beloved President."

The Chairman declared that the following had been elected to fill the several offices.

The names in *italics* are those of members who have not, during the past year, filled the offices to which they have been elected.

President.

H.R.H. the Prince of Wales, K.G.

Vice-Presidents.

H.R.H. the Duke of Edinburgh, K.G.	Sir Rutherford Alcock, K.C.B.
H.R.H. the Duke of Albany, K.G.	Sir George Birdwood, M.D., C.S.I.
Sir Frederick Bramwell, F.R.S.	Duke of Marlborough, K.G.
Andrew Cassels.	W. H. Perkin, F.R.S.
B. Francis Cobb.	*Robert Rawlinson, C.B.*
Sir Philip Cunliffe-Owen, K.C.M.G., C.B., C.I.E.	B. W. Richardson, M.A., M.D., F.R.S.
Captain Douglas Galton, C.B., F.R.S., D.C.L.	Sir William Siemens, LL.D., D.C.L., F.R.S.
Earl Granville, K.G., F.R.S.	William Spottiswoode, LL.D., P.R.S.*
Sir John Hawkshaw, F.R.S.	*Lord Sudeley.*
Sir Frederick Leighton, P.R.A.	Sir Richard Temple, Bart., G.C.S.I., C.I.E., D.C.L.
Sir John Lubbock, Bart., M.P., F.R.S.	*Duke of Westminster, K.G.*

Ordinary Members of Council.

Sir Frederick Abel, D.C.L., C.B., F.R.S.	*Thomas Villiers Lister.*
Alfred Carpmael.	*J. M. Maclean.*
Lord Alfred S. Churchill.	George Matthey, F.R.S.
Thomas Russell Crampton.	Loftus Perkins.
Henry Doulton.	W. H. Preece, F.R.S.
	Admiral A. P. Ryder.
	R. E. Webster, Q.C.

Treasurers.

W. R. Malcolm.	Owen Roberts, M.A., F.S.A.

Secretary.

H. Trueman Wood, B.A.

A vote of thanks to the Scrutineers, moved by the Chairman, was carried unanimously.

A vote of thanks to the Secretary and the other officers was moved by the Chairman, who said that the Society was fortunate in possessing in Mr. Trueman Wood a Secretary devoted to their service, to whom was chiefly due the excellent selection of papers for the evening meetings.

Mr. Cobb seconded the motion, and, referring to the improvement in the finances during the last few years, said that it was largely due to the energy of the officers of the Society.

This vote was acknowledged by the Secretary on behalf of himself and his colleagues.

Lord Alfred Churchill, in proposing a vote of thanks to Sir William Siemens for his services to the Society as Chairman of the Council during the past year, said that Sir William had feared his many active duties would have prevented his giving much attention to the affairs of the Society, but he had fortunately found himself able to do much, and the Society had benefited greatly by his able superintendence.

Sir Philip Cunliffe-Owen said it was with great pleasure that he seconded the motion. The Society had the greatest reason to be grateful to Sir

* Mr. Spottiswoode died on the day of election (June 27).

William Siemens, that amongst all his numerous occupations he had been able to honour the Society by acting as its chairman.

Sir WILLIAM SIEMENS, in acknowledging the vote, said that the Society of Arts had a very old claim upon him. It was, he might say, the first Society with which he became connected, and the first which recognised his labours, by awarding him in 1850 its gold medal.

The meeting then adjourned.

Miscellaneous.

INDIAN WHEAT.

A report to the Secretary of State for India, on Indian wheat, by Messrs. McDougall Brothers, of Mark-lane, has been communicated to the Society of Arts by the India office.

The instructions given were—

I. That Messrs. McDougall should take a given quantity of each of these four representative Indian wheats, viz.:—Fine soft white, superior soft red, average hard white, average hard red, and manufacture them into flour by the ordinary process of grinding under millstones. Also that they should take similar quantities of the same wheats, and manufacture them into flour by means of crushing between rollers, according to the system known as the Hungarian or roller system.

II. That they should take a given quantity of each flour so produced, and manufacture it into bread.

III. That they should note the qualities and other characteristics of the flours produced, also of the offals, viz., middlings, pollard, and bran.

IV. That they should procure the following representative wheats, of fair average quality of the season, as then being sold on Mark-lane market, and, for the purpose of obtaining results for comparison, deal with them precisely as above indicated, both as regards flour, bread, and offals, viz.:—English average, American (red winter), American (spring), Australian average, Californian average, Russian (Saxonska, Taganrog, Kubanka, Ghirka), Egyptian (Buhi, Saida).

Of the two latter qualities of Russian wheats, Kubanka and Ghirka, none was to be obtained in London or other English markets, and consequently were not included in the report.

The report contains an elaborate series of tables, showing the results obtained, and the conclusions come to by Messrs. McDougall are as follows:—

In addition to the particulars contained in the foregoing returns, we have to report that to any one experienced in the requirements of the wheat and flour markets of the United Kingdom and, indeed, of most other countries, it will be evident there is no probability of these Indian wheats coming into demand for manufacture into flour without a liberal admixture of other wheat. They all possess in a marked degree the same characteristics of great dryness, and a distinct beany and almost aromatic flavour, inseparable from wheats grown in the climates and soils of the tropics. Also the flours are ricey, the texture of the breads is too close, and the crust is hard and brittle. But these characteristics do not detract from their usefulness in any important degree. As is well known, a miller cannot show skill in his craft to greater advantage or profit than that with which he selects his wheats, and mixes his grists, so as to produce to best advantage a flour from which bread can be made of the colour, bloom, strength, and flavour desired, and with all a good yield.

We pronounce them to be exceedingly useful wheats, in fact hardly equalled for what is deficient and wanting in the English markets by any other wheats. Their chief characteristics are just those in which the wheats grown in our variable climate are most deficient. Their great dryness and soundness renders them invaluable for admixture with English wheats that are in any degree out of condition through moisture, and the great proportions of the wheats harvested here have been in that condition for some years past, a condition that must prevail in all other than that of wheats harvested and stored during fine and favourable weather; and this the English farmer knows, greatly to his cost, is a state of climate that is by a long way the exception rather than the rule. Added to their dryness, the thinness of the skins of these wheats, and consequent greatness of the yield of flour, must always place them in the front rank as a "miller's" wheat, whenever they are handled with reasonable intelligence and skill.

Such unprecedented yields of flour, as shown by these wheats, ranging (by ordinary grinding) from 77·46 to 80·52 per cent. against English 65·2 and American spring 72·2, speaks volumes in their favour, and their value is still further increased by another point of merit of almost equal importance, viz., a larger per-centage of bread may be obtained than from any other of the flours included in this review.

That, for the best of these Indian wheats (the fine soft white), on the day they were valued on Mark-lane market, a price was offered as high as that for American winters, New Zealand or English, proves that the great value of the Indian wheats is becoming recognised here, a knowledge that will ere long extend to all our markets. The other lots of Indian (Nos. 2, 3, and 4) were lower in value to the extent of 4s. or 5s. per quarter, as might almost have been expected from the difference in colour and other characteristics; still, as these latter wheats become better known here, this difference in price will be somewhat lessened. Their beany flavour is not a serious obstacle, as fair average deliveries, when well cleaned and properly dealt with, can be employed in the proportion of 25 per cent. to

50 per cent, along with home-grown or other wheats, such as Americans, possessing a fine sweet, milky, or nutty flavour.

Glancing at all the facts here elaborated, it is evident that these wheats afford a larger margin of profit both to the miller and the baker than any other.

We venture to record a conviction we have long held, strongly emphasised by the results of these experimental workings, of the measureless importance of the great resources of the Indian empire being developed to the utmost, in producing wheat for this country. Farmers here are finding that to live they must produce beef and mutton rather than grain, hence the greater need of resources of supply under our own control.

ALGIN.

Mr. Edward C. C. Stanford, who read a paper "On the Economic Applications of Seaweed," before the Society of Arts, on February 12, 1862 (*Journal*, vol. 10, p. 185), has lately read a paper on a new substance obtained from some of the common species of marine algæ, before the Chemical Section of the Glasgow Philosophical Society, which is printed in the *Pharmaceutical Journal*. The following facts are extracted from this paper. Mr. Stanford writes:—I believe the algæ, generally, to be quite as valuable food products as the fungi, with the advantage that we are unaware of any poisonous species. Both are, however, equally neglected in this country. As the edible fungi are much consumed by other European nations, so the edible algæ are largely enjoyed, and realise a high price in China and Japan. A sample of one of the Japanese varieties yielded on analysis a composition closely similar to our laminaria. It has, however, evidently been cut up, and presents the appearance of long shrouds, and is coloured green by the action of an alkali. The poor people in Donegal are now eating the *Fucus visiculosus* with Indian meal, and it is a common thing to see the Highland cattle browsing on this plant at low tide. The *Aliaria esculenta*, or murlins, may be called our edible species, but the *Rhodomenia palmata*, or dulse, is perhaps better known in Glasgow, being regularly sold on the streets.

The most important species consumed in this country is the *Chondrus crispus*, or Irish moss. This plant contains 79 per cent. of carageenin, a substance of great gelatising power, and largely used in jellies and puddings. This seaweed would, no doubt, secure a considerable market as a size for fabrics, but it cannot be obtained in any great quantity. It is only uncovered at low spring tides, and any very large demand would soon exhaust the supplies. A recent application of Irish moss is being worked by a limited company, under the name of "velo-plastic," which is said to be made of refuse leather, dried and finely ground, and mixed with carageenin.

Another still more powerful gelatising substance is gelose. This was first imported into France from China in 1856. It has ten times the gelatising power of isinglass, and will set into a jelly five hundred times its weight of water. It is not nitrogenous, and contains—carbon, 42·8; hydrogen, 5·8; oxygen, 51·4. It has not superseded isinglass for jellies, as the fusing point of the jelly is too high to melt in the mouth. I found some years ago, in experiments on every variety of seaweed that could be procured, that this gelatising principle was confined to two British species—the *Chondrus crispus* and the *Gelidium corneum*. An Australian alga, the *Euchemia spinosa* or agar agar, is also a jelly-yielding species. Several articles have recently been introduced under various names, such as thao, fucyne, &c., all of which appear to be modifications of, or products from, these plants.

The application of seaweed as manure is very general where it can be obtained. The only other important proposed application of seaweed has been to the manufacture of paper; and about twenty years ago several patents were taken out with this object, and some specimens were exhibited at the Society of Arts. They were all made, however, from the *Zostera marina*, or grass wrack—a marine plant with flowers growing in the sea, but not one of the algæ—and this plant makes a very good paper. It created a good deal of attention at that time, having been proposed as a substitute for cotton during the cotton famine. It is not available in large quantity, and contains very little fibre. The algæ generally contain no fibre; but, as far as my experiments have gone, nearly every species yields a very pure cellulose, which makes a tough, rather transparent paper. The tissue of the plant consists of simple cells of various shapes laid end to end, and in the fuci containing a dark pigment. This cellulose fabric, which forms the paper material, amounts, when quite dry, to 10 per cent. of the air-dry plant. In working on the fuci and the laminariæ my attempts to make a paper pulp were much impeded by a peculiar substance common to both these species, which was found at first difficult to remove, and the presence of which rendered the paper brittle. In fact this appeared to be always the case, unless the cellulose was obtained quite pure. This substance is present in large quantity, and forms the bulk of the plant after the salts are removed.

Algin has properties which should make it useful for several applications in the soluble form. As a stiffener of fabrics, although not so rigid as starch, it fills the cloth better, is tougher, more elastic, and more transparent. It mixes in all proportions with starch and dextrine, and imparts to the mixture these properties. Unbleached, it forms a cheap material for dressing winseys and such dark goods. Passed through an acid bath, the coating becomes glossy and insoluble, and thus a vegetable mordant is available for dyeing. Lime-water, and salts of calcium, barium, and several metallic salts, may be employed for a

similar purpose; one of its peculiarities being the ease with which it is rendered insoluble.

As a cattle food, there is a large opening for such a material. The agglutinating power of algin enables us to convert into solid blocks many substances which are with difficulty made to cohere. Silica, lime, magnesia, oxide of zinc, phosphate of lime, alumina, chalk, plumbago, charcoal, and many other substances can be converted into solid hard blocks. Some of these compounds may be made by mixing the algin with a solution where both form a joint precipitate with another solution—*e.g.*, sodium silicate, and calcium chloride. One application of this agglutinating character has already assumed importance. Charcoal has been long known as our best solid non-conductor of heat, and no doubt it would have been employed long ago as a covering for steam-boilers, had any medium been known capable of agglutinating it. That is now attained by this substance. My "carbon cement," for this purpose, contains 97 per cent. of charcoal, 3 per cent. of algin being sufficient to make it cohere; and as that charcoal is made from seaweed, it is a remarkable fact that the whole covering is derived from that material. Mr. Spiller, a high authority on the subject, has also found the solution of algin the best thing yet discovered for arresting incrustation in steam-boilers. He speaks of it as highly efficient in precipitating the lime in such a fine state of division that it can easily be blown off from the cock. So that we now propose seaweed, in one form or the other, as a most comfortable internal and external application to our steam-boilers.

The insoluble form of algin is very like horn, and as it can be pressed into moulds of any size it may be used instead of that article. It also appears to be an excellent non-conductor of electricity, and in combination with certain other substances may assist in providing the cheap non-conducting material, which shall be impervious to moisture, now so much required for underground telegraph and telephone wires. It is an efficient agent for emulsifying oils, and, being coagulated by alcohol, for fining wines and spirits.

MINES AND MINERALS OF SERVIA.

The United States Minister at Belgrade, in his recent report to the Government, states that the mineral wealth of Servia, although comparatively little known and not yet thoroughly investigated, is very rich. There are known to exist gold, silver, lead, zinc, copper, antimony, iron (hematite, magnetic iron, and chrome iron), manganese, coal, graphite, petroleum, lithographic stone, glass sand, marbles of various kinds, and cement rock. No geological survey of Servia having ever been made, the mines are known only by outcroppings, and these have been carefully covered up by the peasants in order to prevent their being seized by the Government. Under the old Turkish rule, the policy of the officials with reference to mines was such as to prohibit all development of mineral resources, and the older school of peasants born under, or educated in the traditions of Turkish rule, ascribe involuntarily to the present Government a similar distrust. In addition to this, until new treaties were made after the independence of the country in 1878, it was impossible for foreigners to hold real estate outside certain towns, and even leases were surrounded with such vexatious conditions, that it was difficult for foreigners to invest their money in mining enterprises. The Romans, at one period, worked the Servian lead mines, and left large quantities of scoriæ which contained the entire amount of silver in the ore. Some of these are preserved in the museum at Belgrade. The Venetians also worked the lead ores in Servia, and extracted all the silver that they could obtain with their appliances. They continued to work the silver lead mines down to the fourteenth century, when the arrival of the Turks broke up all the industrial enterprises. In recent years the only mines worked have been the coal mine of Sikole, which is only worked sufficiently to supply the steam flour mill of Negolin, ten miles off, belonging to the proprietors of the mine; the mines of Krupan, in the west of Servia, which contain lead with a rich percentage of silver, antimony, zinc, and iron; and several lignite beds of great extent, which are worked to furnish fuel for steam breweries and flour mills. Each mill or brewery has its own mine, and extracts only enough to feed its own furnaces. For working these mines the Servian Chamber appropriated £40,000, but this amount was all expended in buildings, smelting works, and other preparatory constructions, many of them being unnecessary at that period of the enterprise; another application for a further appropriation was refused by the Chamber, on the ground that it would be "wasted in the same way as the former." In addition to the mines mentioned above, a silver lead mine is being worked at Kutchiana, and a copper mine at Maiden Pek. The present Servian mining laws are not stringent, no special legislation being required for any mining operations. A royalty is paid to the Government, varying from 1 to 5 per cent., on the market value of the metals sold coming from the mines, and after five years working of any mine it becomes the property of the person or company working it. Miners are exempt from military service. Since the country has been thrown open, in consequence of railway construction, the best mining lands in Servia have been taken up, and companies are now being formed to work them. The following are the most important minerals at present existing:—Gold, which is found in the Timok Valley, where the peasants wash the sands brought down by the mountain torrents emptying into the Timok River. This is done only after heavy rains, or when the melting of the snows have brought down a fresh supply of sand. Zinc, which has

never been worked, but of which the ore is plentiful in several localities; copper, which contains a small per-centage of gold; antimony, which mineral has also never been worked in Servia. Some specimens, however, which were sent to Trieste for assay, were pronounced to be worth about 22s. per 100 lbs. The Servian iron ores are generally associated with copper to such an extent as to be worthless for malleable iron, as the copper makes the wrought iron so "red short" as to be unworkable in the forge. There are, however, excellent deposits of hematite and magnetic iron which are free from copper. A large vein of manganese has been discovered near Kladova, overhanging the Danube in a cliff, and has been traced inland for several miles; it is said to be of very pure quality. Coal exists in large quantities, and in many localities, some deposits being of good quality, and others only lignite. Near Alexinatz, a petroleum shale has been discovered on the surface, and after being examined by experts, it has been pronounced very valuable for paraffin and rough lubricating material. Graphite, lithographic stone, cement rock, and feldspathic sand have been discovered in workable quantities, and have been pronounced by experts in Vienna to be of excellent quality. Deposits of lead, both sulphuret and carbonate of lead, frequently associated with silver, are found in many parts of the country. In the immediate vicinity of Belgrade are the deposits of scoriæ from the shafts formerly worked by the Romans. The richest mines known are those at Krupan, giving an ore which produces from 30 to 90 per cent. of metallic lead, and, according to assays made at this mine, yielded from 48 to 64 ounces of silver. These mines at Krupan were also worked by the Romans, and vestiges exist of the old mining town of Saser inhabited by the Saxons, who worked for the Venetians and Ragusans. For salt, Servia is still dependent on foreign countries, chiefly Austria and Roumania. To stimulate explorers, the Government has long made a standing offer of a prize of £160,000 to the discoverer of a workable salt mine. It is believed that salt has now been found, but it is not yet known whether it is in a workable quantity.

General Notes.

School Board Drill.—The Society of Arts' challenge banner was awarded this year, at the annual drill competition of the London School Board Schools, to the Gideon-road Battersea School.

Hospital Administration.—A Conference on Hospital Administration, under the auspices of a Special Committee of the Social Science Congress, will be held at the House of the Society of Arts, on Tuesday, July 3rd, at 11 a.m., which Conference will be continued on Wednesday, July 4th, at 11 a.m.

Tin Ore in the Malay Peninsula. — It appears that in 1882 the exports of metallic tin from Ferak amounted to no less than 7,000 tons, which equals the production of Cornwall; and about 40,000 Chinese are now engaged in mining works there. A French Company has been formed for working the deposits of tin ore in Malacca.

Experiments with Ensilage.—On Friday, the 22nd inst., in the presence of a large number of gentlemen, Lord Tollemache successfully completed the filling of the first four silos which he has constructed at Peckforton, Cheshire. The grass was taken from an adjacent orchard, and was of very rank quality, unsuitable for making good hay. This grass was carted, damp, by a number of men to a chaff-cutter, with a $15\frac{1}{2}$ in. mouth, worked by a powerful engine, and the grass was cut as fast as five men could cart it away to the silo, which was constructed out of a cart-shed and storage house, lined with concrete walls. Lord Tollemache is confident of the success of the experiment, and maintains that mowing grass which will make six tons of nutritious ensilage, will make only two tons of hay. One silo will be left unopened until April next, in order to thoroughly test its keeping properties.

Cagliari Exhibition.—Information has been received from the Foreign-office, through the Science and Art Department, to the effect that the "International Exhibition of Machinery and Apparatus best Adapted for the Extraction of Water for Irrigating and Cattle-watering Purposes," announced to be held at Cagliari, in May (see *ante*, p. 667), has been postponed until November next. The machinery and apparatus admitted to the show are to be divided into the following classes:—Class 1. Boring apparatus of tubular wells furnished with the respective suction pumps. Class 2. Borers and explorating implements for the search of subterranean waters. Class 3. Water wheels, chains, with buckets for raising water, turbines, centrifugal pumps, hydraulic rams, Archimedes' hydraulic screws, pumps and water-raising machinery of every description. Class 4. Irrigation plans which are recognised of practical execution and economic utility in Sardinia. The prizes assigned by the Minister of Agriculture are:—For the first-class, one gold medal, and the purchase by the said Minister of two apparatus of the system which obtains the first prize, two silver, and two bronze medals. For the second-class, one gold medal, two silver and two bronze medals. For the third class, two gold medals, four silver and four bronze medals. The Minister of Agriculture will purchase, besides, some of the rewarded machinery of this class, reserving to himself the selection and disposal of them. For the fourth class, a gold medal, and 500 lire premium.

Journal of the Society of Arts.

No. 1,598. Vol. XXXII.

FRIDAY, JULY 6, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

Sir William Siemens, the Chairman of the Council, and the Council will receive the members of the Society at a Conversazione, to be held (by kind permission of the Executive Committee) in the buildings of the International Fisheries Exhibition, South Kensington, on Wednesday, the 25th inst. The reception will be held near the entrance.

Their Royal Highnesses the Prince and Princess of Wales have intimated their intention to be present.

It is hoped that the members and their friends will distribute themselves about the buildings and gardens, so as to prevent local crowding, especially near the entrance.

The Exhibition Buildings and the gardens will be open, and lighted by the electric light.

Further particulars as to the arrangements will be given in next week's *Journal*.

The cards of invitation will be issued shortly.

FIRES IN THEATRES.

The following letter, covering the resolutions passed at the meeting of the Society of Arts on Thursday, May 31st, has been forwarded to the Secretary of State for the Home Department, and its receipt acknowledged :—

Society for the Encouragement of Arts,
Manufactures, and Commerce,
John-street, Adelphi, London, W.C.
21st June, 1883.

Sir,—I am requested by the Council of this Society to forward for your consideration the enclosed copy of three resolutions, which were passed at a meeting held here on the 31st of May last, to consider the question of the best means of preventing fires in theatres.

The Council think that all the resolutions are worthy of serious consideration, but they believe that the third one, dealing with the question of inquiry into cases in which there has been serious loss of property without actual loss of life, is the most important. The Council are convinced that this resolution points to a much needed reform, and they would specially urge that, when the experiment was tried for a short period, about the year 1847, by the late Mr. Serjeant Payne, the results were such as to warrant the practice being permanently adopted, and to render it a matter of regret that, under the existing law, it is not possible for it to be carried into effect. The Council are so fully impressed with the importance of the question that they venture to express a hope that you may, after such investigation as may seem desirable, see fit, at some convenient time, to introduce into Parliament a measure for the establishment of official inquiries such as they recommend.

I have the honour to be, Sir,
Your most obedient servant,
(Signed) William Siemens,
Chairman of Council.

The Right Hon.
Sir William Vernon-Harcourt, Q.C , M.P.

PATENT LAW REFORM.

On the 28th ult., a deputation, representing the Council of the Society and the British Association Patent-law Committee, had an interview with the Right Hon. Joseph Chamberlain, M.P., President of the Board of Trade. The deputation was introduced by Sir John Lubbock, Bart., M.P., and consisted of Sir William Siemens, F.R.S., Sir Frederick Bramwell, F.R.S., Mr. E. Carbutt, M.P., Captain Douglas Galton, C.B., F.R.S., Mr. W. Barlow, F.R.S., Mr. Alfred Carpmael, Mr. A. T. Atchison, and Mr. H. Trueman Wood. Sir William Siemens and Sir Frederick Bramwell laid before Mr. Chamberlain the points in which the two committees of the Society of Arts and the British Association

believed the Bill, as drafted, specially required amendment. Mr. Chamberlain agreed with their views on many of these points, but expressed himself strongly as to the impossibility of getting the Bill passed if large alterations had to be made, and suggested the propriety of such changes as were required being made, as far as possible, by verbal alterations on the Government Bill, and not by the introduction of entirely altered clauses. With regard to the government of the office, he distinctly stated that the Government was not prepared to accept any amendment which would substitute a board of three commissioners, as proposed in the Society of Arts' Bill, for the single comptroller proposed in the Government Bill. He was understood not to lay much stress on the appeal granted under certain circumstances in the Bill to the law officer, but stated that the plan had been adopted, because it was thought that a simpler and cheaper tribunal would be provided than if the appeal were to a court of law. As regards inventions communicated from abroad, he was quite prepared to accept any alterations which might ensure that British patents should only be granted to the actual foreign inventor, and would further agree that such an inventor ought to be protected against his English patent being invalidated by publication in England of a description of his invention. He quite agreed with the deputation that the demand for claims in the provisional specification was a mistake, and he had already prepared amendments dealing with this point. As regards publication of the notice of application, he understood that this would be done by rule, but saw no objection to the insertion of a clause providing for this matter in the Bill. On the question of examination of specifications, he was disposed to assent to the proposition that no examination should be made into the subject matter, but that the examination should be limited to the form of the specification itself. He thought that this alteration would go a long way to meet the views of the deputation as expressed in the amendment, which proposed the granting of a patent under any circumstances at the applicant's own risk, but endorsing such patents. After some little discussion, it was considered that this concession should be accepted as being as satisfactory as, under the circumstances, it seemed possible to obtain. As regards opposition, Mr. Chamberlain undertook to give the views of the committee full consideration, but would prefer that the question should be reserved until he had obtained further information upon it. At all events, he was quite clear that opposition should be limited, as proposed in the Society of Arts' Bill, to persons who had reason to believe they had been defrauded, and he was inclined to think that, with such limitation, it was not of very great consequence whether the opposition was on "open" or closed documents. As to racing for the seal, he believed that the clause dealing with this point in the Government Bill was sufficient, and he did not like the proposed addition, stating that, in the event of more than one application for a patent for the same invention, each patent might be sealed. He would, however, agree to the insertion of words stating that the sealing of one patent should not be a bar to the sealing of a second, if previously applied for, and the deputation agreed that this would have the effect required. As regards amendment, he was prepared to a great extent to accept the enlarged powers proposed in the Society of Arts' Bill, provided the desired end could be attained without alterations in the Bill of too sweeping a character. As regards prolongation, the deputation laid before Mr. Chamberlain the objections felt to the continuance of the present system, under which prolongations are granted by the Privy Council, and it was understood that Mr. Chamberlain would give this point his consideration. The proposal to insert a clause limiting the power of the Crown over patents, Mr. Chamberlain met with the remark that this was really not a matter within his competence to decide, and suggested that application should be made to those departments of Government which were likely to be affected, especially the War-office, the Admiralty, and the Post-office. There were also some other points of detail which the deputation brought before the President of the Board of Trade, and to which he undertook that attention should be given. In conclusion, Mr. Chamberlain suggested that the amendments of which Sir John Lubbock had already given notice should be modified so as to bring them into harmony with the result of the discussion, and stated that if this could be done, he would be prepared to accept them in committee. The feeling of the deputation was that the result of the interview had been most satisfactory; and, at their request, Sir John Lubbock undertook to prepare a series of modified amendments. This he has since done.

Miscellaneous.

ENGLISH GOODS AND CHINESE BUYERS.

By Lieutenant the Hon. H. N. Shore, R.N.

The "Commercial Reports from Her Majesty's Consuls in China" give a very considerable insight into native manners and customs, besides supplying some curious and suggestive facts in connection with the foreign intercourse of the empire.

Taking those for the year 1880—the latest to hand at the time of writing of this—it will be found that the foreign trade of China for that year reached the very respectable figure of 45½ millions sterling, of which Great Britain and her dependencies monopolised the lion's share, in the shape of about 73 per cent. of the whole; the principal imports being opium and cotton goods, in exchange for which China supplied us with 140 million pounds of tea—110,725,000 lbs. of the value of £5,594,000 coming from the port of Foochow alone—besides silk, and a variety of articles of minor importance.

Cotton goods, principally of English and American manufacture, find a ready sale in China, as the familiar quotations of "grey shirtings" in the commercial columns of the daily papers always remind us. But the enormous demand for goods of this nature is due to a fact of which few people in this country are perhaps aware, namely, that the Chinese nation almost entirely clothes itself in cotton, in one form or another; warmth in winter being obtained by means of wadded garments, which are piled on until the wearer assumes somewhat the aspect of a stuffed doll. Hence the severity of the weather is not infrequently expressed in terms of clothing by Anglicised Chinese—as, for instance, "a two-coat day" or "three-coat day." Furs, of course, are worn by the wealthier classes, but their prices debar the poor from using them, so that, when the cold weather commences, the nation literally wraps itself up in cotton wool until the return of spring. The inability of cotton garments to withstand wet, has the effect of making the people very averse to working in the open during rainy weather; and the proverbial dislike of the nation to cold water, whether in its outward or inward application, has sometimes led to strange results. Take one. The terrible outbreak at Tientsin, which resulted in the massacre of the unfortunate French Sisters of Mercy in the year 1872, was followed by a tremendous downpour of rain, and to this, which had the effect of damping not only the clothes but the ardour of the mob, has been attributed in no small degree the escape of the entire foreign community from the fate which befell the Sisters.

With regard to foreign cotton goods, complaints have been frequent of late years amongst the native purchasers, as to the quantity of "size" and "China clay" used in their manufacture, resulting in mildew and rot; and a certain amount of prejudice has sprung up in consequence, against their use. But the native merchants are a good deal to blame themselves for this state of things—as in some instances they are very ready to admit—insisting, as they do, on having a cheap, inferior article, in preference to better and higher priced goods.

Putting aside all questions as to the morality of "loading" cottons, there will always be a demand for cheap sized goods for certain uses, as, for instance, mourning clothes, which are worn at certain times of the year by all classes, for shrouding the dead, for funeral hangings, which become the perquisites of the attendants, as well as for the inside of the winter wadded garments. On the other hand, cotton goods of native manufacture are still preferred by the majority of the working classes, for their superior lasting powers; the native methods of washing cotton clothing, by means of soda and "stone-banging," wearing out all but the strongest fabrics in a very short time.

The material known as Turkey red is in high favour with the Chinese, owing to the brightness of the colour, its permanency, and the durability of the material. There was a great demand for it a year or two ago for the purpose of clothing the recruits, who had been hastily collected to resist the threatened Russian invasion. An army clothed from head to foot in Turkey red would be a somewhat novel and startling feature in Eastern warfare. Chinese generals, be it observed, attach a great deal of importance to moral effect.

The great and increasing demand for foreign cotton goods has inspired certain prominent Chinese officials with the idea of erecting cotton mills on Chinese soil, to be owned and worked by natives, with a view to competing with the foreign manufactured article, and meeting the demand by goods of native make. It must be remembered that China is the home of cotton, and although the cotton of native growth is somewhat short in the fibre, the production is enormous, and it is easy to see that the establishment of a native manufacture must have an important effect, ultimately, upon foreign trade. The scheme, so far, has not, however, advanced much beyond the embryo stage.

Without going deeply into the question of the respective merits of "camlets," "long-ells," "lustres" and "Spanish stripes," it may be remarked briefly, that the demand for woollen goods is only moderate, and is not likely to increase for many years to come; woollen garments being as much a luxury with the Chinese as silk is with us. Besides which, the difficulty of preserving woollen goods from the attacks of moths and other insects, when laid by in the pawn shops during the summer months, prevents them from coming into general use with the natives. Curiously enough, the demand for woollen goods, as we have seen to be the case with cotton, is influenced to a great extent by military movements, the strength,

warmth, and lightness of woollen clothing having lately induced the "Army Clothing Department," or its Chinese representative, to substitute it for the wadded clothes with which the Celestial "braves" have hitherto encased themselves in winter: so that the abstention of a Chinese army from active operations in the field during rainy weather can no longer be reckoned on!

In this branch of trade, also, there are signs that the Chinese are about to compete with the foreign article, woollen mills having recently been established under official auspices, in one of the central provinces, the machinery having been supplied by a German firm.

So much has been said and written lately about opium, that it is needless to discuss this much-vexed question here. We will merely note the fact that its consumption is increasing at a rate which must prove very gratifying to producers, and alarming to philanthropists. "The truth about opium" seems, however, to be as far off settlement as ever.

After opium and cotton goods, it would seem that needles, matches, window-glass, and kerosene-oil are some of the first foreign conveniences for which a demand springs up, and the extraordinary development of the trade in these articles of late shows that the Chinese are not, after all, so wedded to "old custom" as to be averse to change, when the advantages of doing so are clearly apparent.

First, as to window glass, although it is still too expensive to come into general use, it is no uncommon thing, in passing through villages which have come within the radius of foreign trade, to find a centre pane in cottage windows, those of the wealthier classes being often glazed throughout. It may be as well, perhaps, to remind our readers here that oiled paper is the common substitute for window glass in China; a semi-transparent shell, somewhat resembling mica, being also used for this purpose. As an instance of the increasing demand for glass, the following figures are worth noting. At the newly-opened port of Wu-hu, on the Yang-tse-Kiang, the importations increased from 9,100 square feet, in 1877, to 47,000 square feet in 1880. Again, at Wenchow, the importations for the same period increased from 7,400 square feet to 28,200 square feet.

The great demand which has sprung up for foreign matches shows that the foreign manufacturer has the field to himself, and if it goes on increasing in the same ratio as heretofore, flint-and-steel will soon be a thing of the past in China. The Swedish safety match is very popular, but Bryant and May's are said to be first favourites; their reputation is, however, being endangered by large importations of an inferior article with counterfeit labels, as well as by bad imitations manufactured in Japan. The Japanese, indeed, are gaining an altogether unenviable notoriety by the fraudulent imitation of European goods, as well as by the disregard of the patent-laws, and those of copyright.* The development of the match trade during the last few years may be gathered from the following returns. At Hankow the importation increased from 42,980 gross in 1877, to 324,317 gross in 1880, while at Tientsin the figures were nearly doubled in one year, rising from 92,000 gross in 1880, to 181,540 in 1881.

Foreign needles are in high favour with the Chinese, from their great superiority to those of native manufacture. Here, again, we must have recourse to figures, as showing the prodigious proportions the trade has assumed. From 703,000 mille, in 1879, at Shanghai, the importation rose to 1,059,000 mille in 1880; the importation at Tientsin for the latter year being shown in the returns as 1,016,000,000! But the article of foreign commerce which threatens to distance all other competitors in point of popularity is kerosene oil. The development of the trade in this article has been remarkable of late. It is entirely supplanting the native bean and tea-oil, which has done duty hitherto for lighting purposes, and may be truly described as supplying a want long felt, Chinese social economy being sadly deficient in good house lights. The cheapness and brilliancy of the oil in burning makes it a great favourite. It has found its way to the most distant parts of the empire; nearly all shops are lit by it, and for hundreds of miles round many of the ports opened to foreign trade, almost every cottage will be found with its small tin lamp of native make for burning the oil. Its cheapness has had a somewhat undesirable result in Shanghai, so far as shareholders in the gas company are concerned, having prevented gas from coming into general use amongst the natives, who, it is stated, prefer to buy their oil in small quantities as they want it, instead of running up gas bills without any satisfactory check on household expenditure.

The oil is at present almost entirely supplied from the factories at Philadelphia, and the trade is practically a monopoly. From the high popularity it enjoys, there is every reason to suppose that, until the petroleum wells which are known to exist in China are opened up, the importation of the foreign article will continue to increase for many years to come. The extent of this increase may be gathered from the following returns. At Hankow, the imports rose from 27,976 gallons in 1877, to 285,157 gallons in 1880; at Wu-hu, from 2,190 gallons to 71,110 gallons during the same period; while the returns for Shanghai show that, in 1879, the importation reached the prodigious total of 4,780,440 gallons.

Amongst the smaller items of trade, a considerable demand has sprung up of late for old iron, such as hoops from bales of goods, boiler-plates, tires of cart wheels, but especially for old horseshoes, as being easier to work up into agricultural implements, anchors, &c., than new iron. Horseshoes are mostly used for the manufacture of knives, and for fish-plates

* A Chinese poet at Ningpo, who made a livelihood by printing and selling his productions, has been nearly ruined by cheap editions printed from metal types in Japan. Chinese books, it may be observed, are printed from wooden "blocks" cut out by hand.

for strengthening the axles of native carts. So great is the demand for old iron, that, at Shanghai, literally acres of ground are said to be covered with it, waiting for transport to the interior. The greater part of this comes from England, in the form of ballast for ships; and, at a recent discussion at the Society of Arts' rooms, on the subject of the utilisation of waste, the loss of all this valuable material to this country was much deplored.

Brass buttons of foreign make are becoming very popular with the natives, who find them less easily tarnished, and more durable than those of home make. They are used for fastening the short sleeveless jacket worn over the long robe, for securing which native buttons are used.

Foreign soap is coming into extensive use, and is a favourite form of gift; so, no doubt, before long, we shall have the testimony of some Chinese belle, as to the matchless efficacy of a certain soap for the hands and complexion, added to that of "the Nightingale, the Lily, and the Rose!"

Biscuits from Messrs. Huntley and Palmer and Peek and Frean, as well as Morton and Company's preserved provisions, are familiar objects in native shops, and, with bottles of foreign sweetmeats, which now often find a place amongst the articles of dessert offered to guests, meet with a ready sale.

Even furniture of foreign make is beginning to find its way into better class Chinese houses, though chairs have not as yet advanced much beyond the straight-backed stage.

Foreign cutlery is freely used, and native artisans readily admit its superiority, attributing this to the advantage we derive from the use of machinery; while even fire-engines are beginning to take the place of the harmless native squirts, which to the intelligent foreigner have always seemed more adapted to the watering of rose gardens than the quelling of flames; several having been ordered by the officials at the recently opened port of Wu-hu. The Consular reports from this town also make mention of the opening of several shops for the sale of foreign goods, such as kerosene, soap, lamps, clocks, toys, hearth-rugs, photographs, and a variety of fancy articles, and state, moreover, that these shops are usually crowded with country people, who flock in from miles around, to buy "foreign novelties."

Apropos of these "foreign novelties," it may be remarked that the utter trash which forms the principal stock-in-trade of native shops devoted to the sale of this class of foreign goods, shows that the native purchasers are not very discriminating, and further leads one to suppose that all the refuse and rubbish of the European markets is ultimately sent out to China, to be disposed of to the guileless Celestials. They do find purchasers notwithstanding, though we venture to say that the contents of a drawing-room owned by a Chinaman who has come within the influence of foreign ideas, would send a thrill of horror through the soul of a modern æsthete; looking-glasses of the most tawdry description, gold and silver balls, chandeliers of wondrous device, and chimney-piece ornaments, startling alike in colour and design, being scattered about the room with lavish profusion. It is only fair to add, however, that the native "China maniac" is often a person of refined and discriminating taste, with a veneration for antiquity far exceeding that of his western *confrère*.

With the exception of tea and silk, the exports from China to England are few, and comparatively unimportant; of these we may mention straw braid as occupying a rather prominent position. This is produced in the country round Chefoo and Tientsin, but the trade is a very uncertain one, being subject to fluctuations depending on a variety of causes, as, for instance, the wet summer of 1879 caused so small a demand for straw hats that there was a decrease in the exportation of braid to the extent of over £63,000. In the preceding year, the London market took as much as 3,761,833 lbs. On the whole, the trade is a steadily increasing one.

Straw hats are made in great quantities in the neighbourhood of Ningpo, from a kind of reed which grows luxuriantly in the surrounding lakes and marshes. As many as 11,996,446 of these were exported in 1878, being sold for less than a penny a-piece in Europe, where they are worn mostly by the peasants of France and Switzerland.

China also sends us sugar and tobacco; the latter, after being manufactured, is often sold as Turkish, and made up with Cavendish.

Of China-ware and curiosities, there is an increasing exportation every year. A well known curiosity dealer in Shanghai has a shop in Paris for the disposal of his goods.

As regards rhubarb, of which we receive a good deal from China, the natives at one time laboured under the belief that it was a necessity of life with foreigners, and that the stoppage of our supplies would entail most serious consequences.

That the foreign trade of the empire is only yet in its infancy, is a fact which is pretty generally admitted, and is evident on the face of things; indeed, the opinion has been freely hazarded by intelligent foreigners in China, that our trade in many parts of the country has not yet penetrated below the middle class, the merchants and officials; and that when the lower-classes begin to use foreign cotton goods, the trade will increase enormously. As regards British manufactures, the consumption at the present time is not what one would expect from the extent of the population; and a comparison has been instituted with India, which, with its 253 millions, took £22,714,000 of British goods in 1879, against only £8,268,000, taken by China, with its 400 millions.

There is a feature, moreover, of the foreign trade of China, which the reports of successive years bring into increasing prominence, and that is the way in which the native merchant is gradually pushing the foreigner out of a field in which he has hitherto enjoyed a monopoly. In point of fact, John China-

man is slowly, but no less surely, taking the export and import trade of the country into his own hands. Content no longer to maintain an attitude of sullen and dogged resistance to foreign innovation, he is assuming the offensive in a very energetic way, with the evident intention of carrying the war into the enemy's camp, and fighting him with his own weapons. Every year tells its tale of foreign merchants in the "treaty ports," who have been forced to succumb to the keen competition of the natives. Instances might be mentioned in which the presence of the foreign merchant is only tolerated on the condition that he buys and sells on terms dictated by the powerful Chinese commercial guilds, the slightest deviation from which draws down the wrath of these bodies in a form which proves irresistible. A system of "boycotting" the foreign merchant has, in fact, been adopted by these societies, which has not only proved the ruin of individuals who have been rash enough to assert their independence, but has caused the withdrawal of the agencies of many well-known and long established houses. It must not be inferred from this, that the closing of agencies in the out-ports necessarily means a decrease of trade; every new port which is opened taps a fresh district, and creates new markets for foreign goods; but the tendency is for Shanghai to become more and more the great commercial *entrepôt* for North China—the great centre for the introduction of foreign goods into the empire. Steam communication has so greatly facilitated locomotion, by bringing many large commercial cities within easy reach of Shanghai, that the native merchant is no longer content to buy his goods from the somewhat limited stock at the out-ports, but must run up to Shanghai, where he has not only a larger choice to select from, but by taking advantage of the auctions, can obtain his goods at a cheaper rate. The trip to Shanghai, moreover, presents an opportunity for combining business with pleasure, which has a great fascination for the Provincial Chinaman; the novel sights and dissipations of the great commercial capital leaving an impression on his mind, which he is glad to renew at the earliest opportunity.

In view of the fact that the export and import trade of China is gradually passing into the hands of natives, it behoves the foreign merchant very seriously to consider the causes which are operating in favour of native competition. In any case it would seem that, to compete successfully with the native merchant on his own ground, more economical habits of living and doing business must be adopted than have been in vogue hitherto. Though it is difficult to see how, even this will avail in the face of the "boycotting" tactics of the rich commercial guilds. Some acquaintance with the language, moreover, would seem to be essential to success now-a-days, together with a wider acquaintance with native manners and customs, and a knowledge of the various appliances in everyday use amongst the natives, with a view to meeting their wants. Merchants would then be spared the disappointments and losses arising from sending out consignments of articles for which domestic economy can find no use. To quote from Consul Alabaster's report—"There is still a field open to our manufacturers in cutlery and ironware generally, which has been so far comparatively unworked, for the Chinese have none of our manufacturers' appliances, and when their needs are understood, we might supply them at a great advantage over the native manufacturers; but it is no use sending out invoices of table knives which the Chinese do not use, or scissors which are not adapted to their fingers, locks they cannot fit on their doors, or pans and trays they cannot find a use for. Native models might be departed from with advantage in nearly every case, but the conditions of employment must necessarily be considered. A padlock in China has to fit through two staples. Shears are used generally in place of scissors. There are no nails to pare, pens to mend, or corks to extract in a Chinese household. They do not use pins or steel pens, or fenders, or scrapers, or iron tea-trays, but they have inumerable wants which we might profitably supply." Mr. Alabaster's suggestion that "a collection of the articles in common use among the people, accompanied by explanations of the reasons for the forms taken under existing circumstances, and notes of cost, might be made with advantage and exhibited at one of the centres of our iron manufacture" is one that should commend itself to the very serious consideration of our chambers of commerce, but especially to all who are interested in the trade of this country with China. A tithe of the money which has been expended at South Kensington, laid out intelligently in the furtherance of this object, would place our manufacturing industry on a far more advantageous footing in regard to the China trade than it is at the present moment.

American manufacturers have already taken the initiative in the direction suggested. But the most practical measure of all, and one, moreover, which the Government of this country would do well to copy, is the establishment of a great commercial museum at Brussels, under the control of the Minister of Foreign Affairs, for the purpose, according to the declaration of the Belgian Government, of exhibiting specimens of raw materials, manufactures, and appliances of all countries, with a view to conforming native manufactures to the tastes and wants of foreign markets; and to this end the Government has directed its consuls and other foreign agents to collect samples of the manufactures in use, to ascertain the styles and patterns most esteemed, and to send them home to this museum; and finally, "these officers are especially enjoined to send home specimens of metallic ores, textile fabrics, and all such raw materials as may in any way be capable of being converted into useful products, that the genius of the Belgian manufacturers may be stimulated to a more diversified production." (Résumé of report in *Journal of Society*

of Arts, Dec. 22, 1882.) It is evident that such a museum will have a far-reaching influence on Belgian manufacturing industries, as well as on the foreign trade of the country.

The time is, no doubt, still remote when China will be able to dispense with European manufactures, but in every direction there are signs that this great hive of cheap labour is waking up to the necessity of meeting its own wants, and of destroying the monopoly which the foreign merchant and manufacturer has hitherto enjoyed. The various schemes which have been mooted, and partly carried into effect, for the establishment of woollen and cotton mills; the gradual opening up of the mineral resources of the country; but especially the position of unassailable security now enjoyed by that purely native concern, "The China Merchants Company," which, with the large fleet of steamers it now owns, is no longer content with wresting back a considerable portion of the coasting and river trade from the foreign companies, but is gradually extending the sphere of its operations to foreign ports, and has actually started a line of steamers to run to England, with a native agency located in London — all tend to show the determination of the Chinese, not only to have the foreign trade of the country in their own hands, but to render themselves independent of foreign assistance. And if we consider the national characteristics of the people, their dogged perseverance in carrying out the end they have in view, their untiring industry, intelligence, thriftiness, sobriety, and extraordinary commercial capabilities, we may safely predicate their ultimate success; while the vast mineral wealth of China, together with the extraordinary fertility of the soil, points to the great future which is in store for the country.

The very slowness of this great seething mass of Chinese humanity to adopt Western manners and customs, which has excited the ridicule of "the intelligent foreigner," has been rightly cited as a sign of strength; and in spite of the sneers of hostile, critics we shall find ere long that the observation attributed to Prince Kung was no empty boast. "Everything will come in time," he said, "but you foreigners are in too great a hurry. When China does move, she will move too fast for you altogether."

FRENCH FISHERIES IN 1881.

A statistical report of the sea fisheries of France has recently been issued by the Navy Department of the French Government, and contains some interesting information relating to the year 1881. From it, it appears that the number of people engaged in French maritime fisheries in 1881 exceeded 136,000, and the value of the fish caught amounted to 82,500,000 frs. Compared with the catch of 1880, some important differences are to be noted. On the one hand, sardines were not so abundant, and there was a decrease of 962,500 lbs. in cod, herring, mackerel, and anchovies, which gave a total yield of 288,630,000 lbs. On the other hand, oysters, mussels, and other shell-fish show an increased production; there were 230,433,000 more oysters sold in 1881 than in 1880. Though the yield of cod was less in quantity, the prices obtained were, for this reason, in excess of those of the previous year, the excess in value amounting to about £56,000, out of a total yield of £304,000. The general yield of the fisheries was, however, inferior to that of 1880 by £164,000. There was also a decrease of 1,909 fishermen, 611 boats, and 8,942 tons. The French fisheries of Newfoundland gave the largest production of all; and the commander of the station there refers to the good results obtained by the employment of the filets called *trappe*. This net is used independent of seines and lines, and enables the crews to make large hauls without much exertion. It occupies, besides, those who would otherwise be idle when the weather is too stormy to permit of venturing on the open sea, or when fishing with ordinary tackle would prove unsuccessful. In spite of the great storms which caused considerable losses to the crews, the herring fisheries on the coast of Iceland resulted in very large hauls, but the simultaneous returns to French ports of the boats considerably affected the prices, and the result proved advantageous only to the large wholesale fishermen. The sardine fisheries were unfavourable; appearing late upon the coasts, their stay was too brief to be fruitful in results. In some places they did not appear at all. Great improvements are signalled in fishing apparatus. In the west the fishermen have replaced their old boats by chaloupes of a tonnage capable of better resisting the dangers of the sea, and this investment in superior working capital appears to have been amply repaid by largely increased profits. Fisheries with *chaluts*, pocket nets dragged at the bottom of the sea, and cords have been fairly successful. Nearly all the *chalutiers* now take supplies of ice on board, and can thus carry on their work on the coasts of England, Belgium, and even Holland. Oyster fisheries is, at the present time, attracting considerable attention in France. During the year 1880, the oyster product amounted to 144,000,000, valued at about £52,000. In 1881, the capture exceeded 375,000,000 oysters, and a value of £84,000, and oyster fishermen laboured this year under the disadvantages of being prohibited by the Government from fishing in the waters of Saint Malo, Paimpel, and Marennes. The districts of the Isle d'Oleron, Pauillac, and La Ferté, contributed principally to this large increase. Parks or artificial oyster raising gave excellent results. The district of La Ferté exported alone 216,000,000 oysters, reared in the parks. These parks have proved so successful and profitable that they are increasing from year to year. In 1880, there were 41,000 oyster parks in France, covering a surface of 27,000 acres. In 1881, this number had increased by 2,056 new parks, and 800 more acres.

GROWTH OF AUSTRALASIA.

In 1871, the total population of the seven Australasian colonies, which include the five Australian colonies, viz., Victoria, New South Wales, Queensland, South Australia, and West Australia, and the colonies of Tasmania and New Zealand, was only 1,978,740. In 1881, the total population was 2,835,954, showing an increase in ten years of 857,206, or an average of 85·7 per cent. Ten years ago, the combined exports of the same colonies amounted to approximately £67,000,000, and, in 1881, £105,000,000, showing an advance of more than 50 per cent. This is equal to about £38 per head of population. The public revenue of the seven colonies during the year 1881 amounted to about £21,000,000, against £18,000,000 in 1880, being an increase of £3,000,000. The colonies possess 5,426 miles of railway, 49,105 miles of telegraph, 78,000,000 sheep, the wool clip of which last year realised the sum of about £21,000,000, besides 8,691,910 cattle and several millions of horses and pigs. During the year 1881, 16,690 vessels, of an aggregate tonnage of 9,504,130, touched at the various ports of the colonies. The same colonies have 7,017,380 acres of land under profitable cultivation, and produce annually about 30,000,000 bushels of wheat, and 11,717,819 bushels of oats; of these latter, New Zealand alone produces 6,924,848 bushels.

ASPHALTE DEPOSITS IN MEXICO.

A variety of bituminous substances, from the pure hard asphaltum to the fluid petroleum, are known to exist in immense quantities along the coast of the Gulf of Mexico, chiefly in the States of Tamaulipas, Vera Cruz, and Tabasco, but there appears to have been no organised efforts to utilise the deposits either for domestic purposes or for commerce. Consul Cassard, of Tampico, says that almost inexhaustible beds of asphaltum exist on both banks of the river Thamesi, about sixty miles above that port, being found in a comparatively pure state, and containing only an insignificant proportion of foreign matter, chiefly vegetable, which it gathers while oozing through the sedgy borders of the river. The substance may be gathered with little difficulty, but as the locality is only accessible to boats of light draught, the beds are comparatively neglected. Asphaltum, or *chapopote*, as it is called in Mexico, is frequently found floating in masses on the rivers and lagoons, and is cast up on the beach by the waves all along the Gulf Coast, and especially in the vicinity of Tuxpan, and on the Grijalva River in Tabasco. These masses, by the local law of flotsam, are the property of the finder, and are sold at the rate of from eight to nine shillings the hundredweight. In the state of Vera Cruz asphaltum is found in considerable quantities, the principal deposits being in the canton of Jalacingo, in Minatillan, in the canton Ozuluama, where several deposits of petroleum, asphaltum, and coal, are known to exist in a place called El Chapopotito, in the municipality of Panuco, in Papantla, in Tuxpan, and Tomtoyuca. In Vera Cruz, near the village of Moloacan, a few miles distant from the river of Coatzacoalcos, there is an immense deposit of asphaltum, which, at some places, is found pure, and at others more or less mingled with rock salt and saltpetre. According to Dr. Hechler, a German traveller who visited it, the "salt mine," as it is popularly called, is an isolated spur, branching off from the main ridge, or cordillera. This mountain is from 1,000 to 1,200 feet in height, and with a base of from three to four miles in extent, of cone shape and cracked by earthquakes; on its slopes are found a number of pits, some cold and still, others seething and bubbling, and emitting a stifling odour. These pits appear to have cavernous communication with the internal fires of the mountain, which, as indicated by the external heat and frequent subterranean noises, contain vast masses of material in a state of combustion. The whole adjacent surface consists of asphaltum partly solid and partly liquid, and more or less mixed with rock salt. So extensive are these beds that the supply may be considered inexhaustible. In some places the seething pits eject considerable quantities of asphaltum in a liquid state. Extensive beds are also known to exist in the State of Chiapas, on the upper waters of the Grijalva river, which has its course through the State of Tabasco and empties into the Mexican Gulf, near Frontera.

PETROLEUM SUPPLY OF BAKU.

According to a detailed statement on the above subject, lately made before the Berlin Association for commercial progress, by Professor Liebermann, there is at present a remarkable development of activity in the Russian petroleum industry. There are at Baku about 200 small distilling works, and also several large establishments. In the year 1881, there were distilled, at Baku, about 1,400,000 tons of raw naphtha, which yielded about 180,000 tons of illuminating oils.

The most important factory is said to be that of Messrs. Nobel, which has lately extended its operations, and has at the same time increased its capital from £900,000 to £1,500,000. The springs are about eight miles distant from their works, and the transport of naphtha is effected by a five-inch pipe, through which 1,600 tons are daily conveyed to the factory. It is intended to replace this pipe by one six inches in diameter.

The factory produced illuminating oils, in 1880, to the extent of about 22,000 tons; while, in 1881 and 1882, there has been a progressive augmentation;

o 50,000 tons and 90,000 tons. It is calculated that a further considerable increase of prodution may be expected during 1883 and 1884.

Notes on Books.

HANDBOOK OF HOUSE PROPERTY: a Popular and Practical Guide to the Purchase, Mortgage, Tenancy, and Compulsory Sale of Houses and Land. By Edward Lance Tarbuck. Second edition. London: Lockwood and Co.

This work is divided under the three headings of (1) Law affecting Land and Houses; (2) Practice in Valuations; (3) Building Houses; and contains information respecting the purchase and sale of the various kinds of landed property, such as freeholds, life interests, leaseholds, and copyholds. The many questions relating to dilapidations and fixtures are fully discussed, and the law relating to them is explained.

THE FISHERIES OF THE ADRIATIC. By G. L. Faber, Her Majesty's Consul at Fiume. London: B. Quaritch. 1883.

This work, which Mr. Faber modestly terms a "Report," is really an elaborate monograph of the fisheries of the Adriatic, and all connected with them. Besides an account of the fishes inhabiting that sea, and a detailed list of the various species (giving besides the scientific, English, and Italian names, the local names by which the fish are known), there are descriptions of the different methods of catching them, the craft and gear employed, methods of cooking and curing, statistics, &c. In a brief preface, which Dr. Günther has written for the work, he draws special attention to the system adopted by the Italians, of rearing the fry of marine fishes, mullets, flat fishes, eels, &c., in enclosed waters to a marketable size, "a practice yielding direct and immediate profits." Amongst the systems of fishing described, will naturally be found many having their counterparts in our own waters, such as those involving the use of the trawl and the sieve. Others, again, are unlike any known in more northern latitudes, such as the tunny fisheries. In these the *thunnoscopos* of Aristophanes, of Aristotle, and of Theocritus, still watches, perched on the top of his ladder, to signal to his comrades the entrance of the great fish within the semicircle of the net stretched out from the shore, that these may haul in the slack end of the net and enclose the fish. Of all the various systems Mr. Faber gives a full account, and his descriptions are illustrated by figures of the boats, nets, &c., as well as by views of some of the more interesting or important localities.

Obituary.

WILLIAM SPOTTISWOODE, P.R.S.—Mr. Spottiswoode had been seriously ill for several weeks, but the announcement of his death, on June 27th, was scarcely expected by the large circle of his friends, although their fears had been awakened by the daily bulletins. His loss will be widely felt, for besides being, as President of the Royal Society, the representative of science in England, he was connected with a large number of important movements. He had been a member of the Society of Arts since 1856, and, both as an ordinary member and as Vice-President, he was always ready to place at the disposal of the Council his large experience and clear judgment. Mr. Spottiswoode was born in London, January 11th, 1825, and was, therefore, only fifty-eight years of age at the time of his death. He was educated at Eton and Harrow, and at the latter school he gained the Lyon scholarship. He entered Balliol College, Oxford, in 1842, and graduated as a first-class in mathematics at the end of 1845. It was as a mathematician that he made his mark in the scientific world. He published, in 1847, five mathematical papers in quarto, which he entitled "Meditationes Analyticæ;" and his famous little work, "Elementary Theorems relating to Determinants," (1851) was honoured a few years afterwards by being reprinted in Crelle's *Journal*. When Mr. Spottiswoode was requested to allow of its reproduction, he expressed a wish to revise the work throughout. The writer of the life of Mr. Spottiswoode in *Nature* (April 26, 1883) gives 1870 as the date when he especially divided his attention between physics and mathematics, and adds, "his nearest friends induced him to take up the least abstract one of these two branches of science, in order that the general public might have better opportunities of appreciating his abilities." He paid special attention to the phenomena connected with the polarisation of light, and published a volume on the subject in the *Nature* series. No money was spared by him in the collection of instruments, and the experiments with his gigantic induction coil furnished him with matter for several papers for the Royal Society, and lectures for the Royal Institution. Mr. Spottiswoode, from the time of his leaving college, was in the thick of business life, and from then until his last illness he continued the active management of the Queen's Printing-office. His assistance was also largely sought by all the societies with which he was connected. He was Treasurer of the British Association from 1861 to 1874, of the Royal Institution from 1861 to 1873, and of the Royal Society from 1871 to 1878. At this latter date he was elected to the Presidentship of the Royal Society, in succession to Sir Joseph Hooker. He makes the third President who has died in office, the two

previous ones being Newton and Banks. He was also for a time Secretary to the Royal Institution, President of the Mathematical Society, and President of the British Association in 1878, when he delivered at Dublin a remarkable address. His previous address as President of Section A., in 1865, has been described by Professor Sylvester as a combined history of the progress of mathematics and physics. The Institute of France elected him one of their Correspondents, the Universities of Cambridge, Dublin, and Edinburgh conferred on him the degree of LL.D., and the University of Oxford that of D.C.L. Although so fully employed in the active duties of life, he did not allow these to interfere with his investigations of mathematical and physical subjects, as is fully shown by an examination of the list of his papers in the Royal Society catalogue. He acted as an examiner for the Civil Service Commission in its first year of operation, and was subsequently examiner in Trigonometry for the Society of Arts. He was also an active member of the Council of the City and Guilds of London Institute. He served on committees of the Society, and frequently took the chair at the evening meetings. The last meeting of the Applied Chemistry and Physics Section, on May 24th, when Mr. Gordon read his paper on the "Development of Electric Lighting," at which he presided, has a melancholy interest as being one of his last appearances in public. As a large employer of labour, Mr. Spottiswoode was always thoughtful of the comfort of his workpeople, and the several associations for amusement and instruction which they formed, had his active support. He was also an observant traveller and a linguist, but the most conspicuous features of his character were his many-sidedness and thoughtful consideration for all around him. Those who yesterday gathered around his grave in Westminster Abbey felt that while the world had lost a man of mark, they had lost a friend.

General Notes.

Munich Art Exhibition.—The International Art Exhibition, at Munich, was opened on the 1st inst. The building now contains 2,232 oil paintings, 310 water colours, 270 plastic works, and 140 graphic productions.

British Archæological Institute. — The annual meeting of the Institute will be held this year at Lewes, from July 31st to August 6th inclusive, the President of the meeting being the Earl of Chichester.

Caen Industrial Exhibition.—An Industrial Exhibition was opened at Caen, on 3rd June, by the Mayor and Municipal Council. Occupying a large parallelogram on the Cours-la-Reine, the Exhibition contains groups relating to electricity, furniture, saddlery, carriages, and clothing. In the electrical section, two Olry and Grandemange steam-engines drive a powerful Edison dynamo machine, the current from which maintains his glow lamps in incandescence during the evening. A dynamo of M. Meriteus actuates a Berjot arc lamp, and M. Dapury's electric locomotive is exhibited, combined with winch. On 10th June, the *concours regional*, or district agricultural show, was opened, at which all the large implement makers of France were represented. The Exhibition will remain open until the 15th September.

French Tobacco Statistics.—The consumption of tobacco in France is rapidly increasing, and last year showed no exception to the rate of progression, the quantity consumed amounting to 941 grammes (about 21 lbs.) per inhabitant, and representing a value of 9 fr. 76 c. (7s. 9¾d.). In 1881 the quantity consumed was 925 grammes (20½ lbs.) per inhabitant; in 1880, 907 grammes (under 20 lbs.); in 1875, 855 grammes (under 19 lbs.), worth 8 fr. 58c. (6s. 10½d.). According to the returns of the indirect taxes direction, the sales in France during 1882 produced the following amount:—Tobacco for smoking, 164,930,180 fr. (£6,597,207); of inferior quality, 23,209,577 fr. (£928,383); common carotte, 5,765,870 fr. (£230,634); cigars, 57,758,948 fr. (£2,310,358); for chewing, 8,617,619 fr. (£344,704); cigarettes, 16,767,318 fr. (£670,692); and snuff, 78,229,507, fr. (£3,129,180); making a total of 355,339,019 fr. (£14,213,560).

Improvement in Glass Manufacture.—At the meeting, on 4th June, of the Paris Academy of Science, M. J. B. Dumas called attention to the substitution, at M. Appert's glass-works, Paris, of a pressure fan for the blowing into hollow glass ware, that was formerly effected by the mouth of the glass-blower. This long and fatiguing expenditure of breath, accompanied by hard work in a heated atmosphere, proved highly injurious to the health, and even fatal in many cases, if continued for a long period. The new system has been successfully carried out on a large scale by M. Appert, whose drawings and photographs have been referred to the committee on unhealthy trades. The molten glass is kept under pressure in reservoirs, whence it flows in channels to each glass-worker (no longer glass-blower). The latter has within easy reach, and capable of being handled with the greatest facility, a pipe which affords him the necessary quantity of air, at the required pressure for blowing out the globe, bottle, or other object. The germ of this useful and humanitarian invention is due to a workman of the famous Baccarat glass-works, who, by means of a rude air-pump, blew out his glass without using the mouth; he was rewarded with a prize by the Academy forty years ago.

Journal of the Society of Arts.

No. 1,599. Vol. XXXII.

FRIDAY, JULY 13, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CHAIRMANSHIP OF COUNCIL.

On Monday last, 9th inst., at their first meeting, the Council elected Sir William Siemens, D.C.L., LL.D., F.R.S., as Chairman for the ensuing year. The various committees were also re-appointed.

CONVERSAZIONE.

Sir William Siemens, the Chairman of the Council, and the Council, will receive the members of the Society at a Conversazione, to be held (by kind permission of the Executive Committee) in the buildings of the International Fisheries Exhibition, South Kensington, on Wednesday, the 25th July next. The reception will be held near the entrance, and will commence at half-past eight.

Their Royal Highnesses the Prince of Wales, President of the Society, and the Princess of Wales, have intimated their intention to be present.

It is hoped that the members and their friends will distribute themselves about the buildings and gardens, so as to prevent local crowding.

The gardens, as well as the Exhibition Buildings, on this occasion will be lighted by the electric light.

The fountains will be illuminated with coloured fires at 10·15.

The Band of the Grenadier Guards and the Band of the Royal Artillery will perform either in the Building or in the Gardens (according to the weather).

The Band of the 6th Thuringian Regiment of German Infantry (by kind permission of H.R.H. the Duke of Edinburgh, Honorary Colonel of the regiment), and the Hungarian Band, will perform within the building.

A vocal and instrumental concert, consisting of glees, &c., will be given in the Conservatory, from 9 to 11 p.m.

Refreshments will be provided at buffets situated in the following parts of the buildings :—

1. Conservatory (west side).
2. Conservatory (east side).
3. Arcade (west side).
4. Arcade (east side).
5. Centre of Promenade.
6. North end of Swedish Court.
7. West end of British Court (near the machinery).

The only entrance to the Exhibition will be that in the Exhibition-road.

The cards of invitation are now in course of issue.

*** Evening Dress, but there will be no arrangement for receiving hats, coats, cloaks, &c., as part of the entertainment will be in the gardens.

Proceedings of the Society

CANTOR LECTURES.

SOLID AND LIQUID ILLUMINATING AGENTS.

By Leopold Field, F.C.S.

Lecture I.—Monday, January 29th, 1883.

You, who come from stations lighted by electricity, and through streets brilliant in gaslight, may find good cause for wonder that so much can be found to be said upon out-of-date subjects like the Lamp and the Candle: which are the simple equivalents of the title of these lectures.

The system according to which I have concatenated the various bodies, used for lamps and candles, is based upon the theories held by the generality of modern chemists. The diagram (p. 823) shows how every member almost of these myriad — these

Mormon—families, can be assigned to one or the other of the four groups—hydrocarbons, alcohols, ethers, and acids. Hydrocarbons may be regarded as parents of the others, which in theory, borne out to a certain extent by experiment, are derived from them by more or less complicated processes. As their name implies, the hydrocarbons consist entirely of hydrogen and carbon. The relative proportions of these elements in the different series vary by equal increments. First on the list, as to us they are most important, come the paraffins. The white solid familiar to us under that denomination consists of a number of the higher homologues of this series, the composition of which is so nearly identical as to defy the most cunning attempts at isolation. At the present time, twenty well defined paraffins have been individualised. They all conform to one typical formula $C_n H_{2n+2}$, and are all very inert, characterless compounds, to which qualities they owe their name (*parum*, little, *affinis*, akin). The first of the twenty has long been known—it is the joy of the lecturer, as methane; the wonder of the bucolic, as marsh gas; and terror of the miner, as fire-damp. The formula of methane is CH_4. It is a colourless gas, becoming liquid only under extreme cold and pressure. Its sp. gr. is ·55. Here is a cylinder of it: observe the bright, smokeless flame, characteristic of the paraffins generally. In this short, stout tube, there are confined four volumes of oxygen, with two of methane; applying a light, the brisk detonation suggests that methane, at least, has kindred feelings to oxygen. But the methane exists no longer; at the moment of union, water and carbon dioxide — the dreaded choke-damp — were formed—

$$CH_4 + O_4 = CO_2 + 2H_2O$$

Marsh gas is the invariable concomitant of slow organic decomposition. The formation of coal was attended with evolution of this gas, large volumes of which are often stored in coal mines. The mud-volcano of Bulganak, in the Crimea, belches forth pure CH_4. The fire worshippers of Baku, according to O'Donovan,* prostrate themselves before a stream of this gas. It is also seen dancing over marshes, ablaze, as Will-o'-the-Wisp. Methane, and the three following members, ethane, C_2H_6, propane, C_3H_8, and butane, C_4H_6, are gases of density, increasing with their molecular weights. The fifth, pentane, C_5H_{12}, is a liquid at 38°C, and so till the sixteenth, hexdecane, $C_{16}H_{34}$, solid at 21°C. Ethane, C_2H_6, is noteworthy as the parent of alcohol, ether, and acetic acid.

The paraffins allow of substitution products with the haloids, that is, they give up two atoms of hydrogen in exchange for an equal number of atoms of chlorine, bromine, or iodine. This is important, as the *substitution* compounds thus formed are identical with the *additive* compounds of the haloids with the olefins; which are the next series. These bodies have $C_n H_{2n}$ for their typical formula. Like the paraffins, they are colourless, readily inflammable, forming carbon dioxide and water. They are, however, much more easily acted upon by acids, and combine directly with the haloids. Here we have olefiant gas or ethylene, the first of the class, burning with a flame much resembling that of methane. In this jar, inverted over water, I have two volumes of ethylene. Passing up from this bottle an equal proportion of chlorine, you will see the water, at first displaced, soon rise rapidly, while drops of an oily liquid collect in the apex of the funnel, whence they can be drawn off afterwards. This oily pungent liquid is ethylene dichloride, called of old, Dutch liquid. The name olefiant—oil making—is attributable to this property..

The reaction, as before mentioned, is additive, and symbolised thus:—

$$\underset{\text{ethylene}}{C_2H_4} + \underset{\text{chlorine}}{Cl_2} = \underset{\text{ethylene dichloride}}{C_2H_4Cl_2}$$

which is identical with the substitution product formed by the action of chlorine upon methane.

With the exception of cetene and cerotine, constituents of wax and spermaceti, the other olefines are of no interest to us. What renders ethylene of moment is the method of its formation from acetylene, the head of the third series of hydro-carbons, called acetylenes.

The typical formula of these is $C_n H_{2n-2}$. We will only take acetylene itself, C_2H_2. Owing to the preponderance of carbon, you observe it burns with a smoky reddish flame. Though colourless, acetylene possesses a strong unpleasant smell, familiar to all who have allowed Bunsen burners to ignite below. In fact, as methane is always attendant upon slow decomposition of organic bodies, so acetylene is formed in every imperfect organic combustion. The feature of salient interest in its character is its production from the direct union of carbon and hydrogen. When

*O'Donovan, "Merv Oasis."

Hydrocarbons.		(a) Alcohols.	(b)	Ethers.	Aldehydes.	Acids.
C_nH_{2n+2} Paraffins	Methane (Marsh-gas.) CH_4	Methylic (wood naphtha) $CH_3 \cdot OH$		Methylic $CH_3 O CH_3$	Methylic $CH_2 O$	Formic $CH_2 O_2$
	Ethane ..... C_2H_6	Ethylic (wine spirit) $C_2H_5 \cdot OH$		Ethylic $C_2 H_5 O C_2 H_5$	Ethylic $C_2 H_4 O$	Acetic $C_2 H_4 O_2$
	Propane ..... C_3H_8		Glycerin $C_3H_5 (OH)_3$			
$C_n H_{2n}$ Olefines.	Ethylene (Olefiant-gas) C_2H_4					$C_{16} H_{32} O_2$ Palmitic, $C_{18} H_{36} O_2$ Stearic, $C_{27} H_{54} O_2$ Cerotic, $C_{30} H_{60} O_2$ Melissic } Margaric
	.....	Ethal, Cetylic $C_{16}H_{33} \cdot OH$				(And cocoa nut oil acids).
	Cetene .....$C_{16}H_{32}$					
	Cerotene .....$C_{27}H_{54}$	Cerotic .. $C_{27}H_{35} \cdot OH$				
	Melene .....$C_{30}H_{60}$	Melissic .. $C_{30}H_{61} \cdot OH$				$C_{18} H_{35} O_2$ Oleic
$C_n H_{2n-2}$	Acetylene .....C_2H_2					
$C_n H_{2n-4}$ (Terpenes and essential oils)	Turpentine .. $C_{10}H_{16}$	Camphor $C_{10}H_{15} \cdot OH$ (Essential oils.)				
$C_n H_{2n-6}$ (Benzene)	Benzene .....C_6H_6	Phenol..$C_6H_5 \cdot OH$				
	Toluine .....C_7H_8	Cresol..$C_7H_7 \cdot OH$				
$C_n H_{2n-12}$	Naphthaline..$C_{10}H_8$					

Glycerides.

Stearic Glyceride (Stearin) $(C_{18} H_{35} O_2)_3 C_3 H_5$ — Oleic Glyceride, Olein $(C_{18} H_{33} O_2)_3 C_3 H_5$

Palmitic Glyceride (Palmitin) $C_{16} H_{31} O_2)_3 C_3 H_5$

PERMUTATIONS, etc.

1. $2C + 2H = C_2 H_2^{''} : + H_2 = C_2 H_4$ (Acetylene. Olefine.) — 1. Additive formation of acetylene and olefine.

2. $C_2 H_4 + A_2{}^* =$ / $C_2 H_6 + A_4 =$ $\Big\}$ $C_2 H_4 A_2$ $\Big\{ = \begin{cases} CH_2 A \\ CH_2 A \end{cases}$ $\Big\{ = \begin{cases} CH_3 \\ CHA_2 \end{cases}$ $+ \ldots$ — 2. Similarity of *substitutive* paraffin and *additive* olefine haloid (A) compounds.

3. $C_2 H_4 + H_2 SO_4 = \begin{cases} SO_4 H \\ C_2 H_5 \end{cases} : + H_2 O = \begin{cases} C_2 H_5 \\ OH \end{cases} + \ldots$ — 3. Alcohol formed by action of sulphuric acid upon ethylene.

4. $C_2 H_4 A_2 + OH_2 = C_2 H_6 + HA$ — 4. By the action of water upon ethylene, chloride, ethane is formed.

5. $C_2 H_6 O - H_2 = C_2 H_4 O + O = C_2 H_4 O_2$ (Alcohol. Aldehyde. Acetic acid.) — 5. Formation of acetic acid from alcohol.

* A represents atom of Cl., Br., or I.

a stream of the latter is passed over the carbon electrodes of a powerful battery, combition takes place, thus :—

$$C_2 + H_2 = \underset{\text{acetylene}}{C_2H_2}$$

Now, if nascent hydrogen act upon cuprous acetylide, we obtain ethylene, which combination we may depict simply as :—

$$\underset{\text{acetylene}}{C_2H_2} + H_2 = \underset{\text{ethylene}}{C_2H_4}$$

Again, by the action of sulphuric acid upon ethylene, ethylic alcohol, or spirits of wine, is formed :—

$$\text{1. } \underset{\text{ethylene.}}{C_2H_4} + H_2SO_4 = SO_4HC_2H_5$$

$$\text{2. } SO_4HC_2H_5 + OH_2 = \underset{\text{sulphuric acid}}{H_2SO_4} + \underset{\text{ethylic alcohol}}{C_2H_5OH}$$

And as from ethylic alcohol most other organic compounds may be built up, we may be fairly said to have started *ab ovo*, and call acetylene the tap-root of organic compounds. I must not detain you now with the remaining hydrocarbons, the benzines, terpenes, &c., which are adduced as playing, or having played, some part in the drama of lighting. Nor will we linger long over the alcohols, ethers, and acids, except for just such space as will give us an insight into the meanings and propriety of application of the terms. The alcohols owe their name to ethylic alcohol, the alcohol *par excellence*, our national beverage, commonly called spirits of wine. The word alcohol itself comes from the Arabic, *al kohôl*, antimony. This metal, very subtlely powdered, was applied as a pigment to the brows of oriental beauties. Soon any very fine powder was called alcohol. We find Boyle talking of reducing a body to a very "subtile powder, or *alcohol*, as the chemists speak." Ultimately, the epithet passed to all "subtile" bodies, and so to spirit of wine. The modern chemist, then, gave the name to a great order of compounds, which stood respectively in the same relation to hydrocarbons as ethylic alcohol does to its parent ethane; from which it is formed by the substitution of OH, hydroxyl, for H.

$$\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\} + O = \left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}O$$

ethane, or ethylhydride = ethylic alcohol

Ethylic and methylic (μέθυ, wine) alcohols have been used for illuminating ends, when tempered with some carbonaceous substance. Here is pure spirit, burning, as you see, non-luminous; and here some spirit in which camphor has been dissolved. This, you perceive, has a bright flame. But the sole use of methylated spirit to the chemist now is for heating; the flame gives very great heat; as Boyle remarks—"In lamp furnaces wherein I have used spirits of wine for oil, the same flame has melted foliated gold." The alcohol of chief interest to us, though not itself a luminant, is glycerine, of which later on.

The ethers (αἴθω, I burn) may be regarded as formed from the alcohols, by the substitution of another radicle for H. In fact, the alcohols may be called the hydrates of the anhydride ethers, as in metallic compounds of the same nature. So we have ethylic ether, and ethylic alcohol, formed from ethane, which may, in its turn, be regarded as a hydride of the radical ethyl. The following arrangement gives a brief idea of the view which is taken of the formation of the whole chain, from the molecule of hydrogen to that of acetic acid.

$$\underset{\text{hydrogen}}{\left.\begin{matrix}H\\H\end{matrix}\right\}} : \underset{\substack{\text{ethylhydride}\\\text{(ethane)}}}{\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}} : \underset{\substack{\text{ethylhydrate}\\\text{(alcohol)}}}{\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}O} :$$

$$\underset{\substack{\text{ethyloxide}\\\text{(ether)}}}{\left.\begin{matrix}C_2H_5\\C_2H_5\end{matrix}\right\}O} : \underset{\substack{\text{aldehyde}\\\text{(alcohol dehydrated)}}}{\left.\begin{matrix}C_2H_3\\H\end{matrix}\right\}O} : \underset{\text{acetic acid}}{\left.\begin{matrix}C_2H_3\\OH\end{matrix}\right\}O} :$$

Acetic acid is more properly regarded as being formed from methane, by substitution of CO·OH (carbhydroxyl) for H :

$$\underset{\substack{\text{methane}\\\text{(methyl hydride)}}}{\left.\begin{matrix}CH_3\\H\end{matrix}\right\}} + CO\cdot OH\cdot = \underset{\text{acetic acid.}}{\left.\begin{matrix}CH_3\\CO\cdot OH\end{matrix}\right\}}$$

Ether also is itself of no consequence here, but the compound ethers, as tallow and palm oil, will fully vindicate the brief attention we have paid the chief of their clan. The word acid originally meant a substance of a sour taste, which acted upon metals. Working upon the typical properties of the first definite acids, as sulphuric and hydrochloric, the name is now bestowed upon an infinite number of bodies; their qualification being the possession of hydrogen atoms, which they can exchange for metals or radicles. Considering that every flower, berry, insect, animal, metal; in short every body, animate or dead, furnishes a peculiar and distinct acid, it is not surprising that the number is large. Of the substances with which we shall have to deal, cocoanut oil alone furnishes ten different acids, and bees'-wax three.

There is an immense deal more to be said about the permutations and combinations

possible between organic compounds. Time, and the fear of wearying you, forbid my pursuing the subject further. I have, however, drawn up a table of the chief changes mentioned. They are worth attention, as, by their aid, it is possible to furnish some explanation of the changes which nature brings about. Leaving now, this arid but essential preliminary, we will take a rapid retrospect of the art of lighting, see what materials our fathers had at their command, and how they used them.

Probably the earliest known means of lighting was the *torch*, used largely of old in north countries, and still, no doubt, lighting the Lapp and the Finn. This torch has been sent me from North Germany. It is cut from the pitch pine, and sticky with exuded resin. I will light it; you see the red large flame, and the volumes of smoke. This will presently condense into small particles of soot, colloquially termed "blacks," which adhere to faces and clothes with surprising determination, and may give some idea of the eminent comfort experienced in a hall lighted, like the Walhalla, with pine-splinters—*kien-spähne*. We may presume that, in cooking, some of the fat might saturate a brand, which would burn long without consuming its fibre. Or, perhaps, that the readier and brighter combustion of certain woods was attributed correctly to the resin they contained. This is the crude idea of a link—even of a candle. Substituting a rope for a splinter, and saturating this with pitch or resin, we have the *link* that still, on foggy days, connects us with the past. For the word, and, most probably, the idea, comes from the Greek, λύχνος, or perhaps the Latin *luchnus* (Cic.), as the German "fackel," from the Greek φάκελος (*fag*got), a bundle of sticks—after, a torch. Our word torch, though, is evidently the Latin "*tortitium*"—a twisted thing, which would now be applied more properly to the link; while our pine torch finds its Roman equivalent in *taedae*—slips of the *taeda*, or Italian pitch pine — the usual outdoor light of Rome. Funalia, with which Virgil tells us Dido's palace was lighted (evidently from "funis," a rope)—

> "—— dependent lychni laquearibus aureis
> Incensi, et noctem flammis funalia vincunt,"*

* This reminds us forcibly of Milton's description of Pandemonium—

> "——From the arched roof,
> Pendant by subtle magic, many a row
> Of starry lamps and blazing cressets, fed
> With naphtha and asphaltum, yielded light
> As from a sky——

were probably *flambeaux*, a finer kind of link. Here we have specimens both of link and flambeau, disinterred from Lambeth cellars, where they have lain, perhaps, half a-century.

The link, giving an eager, smoky flame, was held by the running footmen or linkboys, who quenched their light in the large extinguishers still to be found on houses of aristocratic antiquity. The flambeau has a centre of oakum, surrounded with alternate layers of rosin and crude beeswax, finished off with a coating of the latter, bleached, which gives it a very expensive appearance. This description of torch was more costly, and gave a cleaner flame than its brothers; and so was principally employed in lighting halls, staircases, &c. At what period the torch was superseded, and whether by lamps or candles, is, and will remain, a moot point. The fact is, the Greeks and Romans, regarding lighting as of very minor importance, were shockingly loose in their nomenclature. Nor are we much better in English. In our translation of the Scriptures the words "candle" and "candlestick" are used indiscriminately with "lamp;" though it is quite certain that a *bonâ-fide* candle was not known. For example, in Exodus xxv. 31, we have "a candlestick of pure gold," but, from the after text, we may be certain that the right word should be "lampstand." Again, in Matt. v. 15, the words "men do not light a candle and put it under a bushel, but on a candlestick," would seem to positively attest the use of both candle and stick at that period, did we not know that the Latin *candelabrum*, and Greek λυχνία, Latin, *luchnuchus* (Cic.), meant "lampstand." Furthermore, as in the parable of the virgins, where oil is a specified condition, the word λυχνὸς is rendered lamp (Matt. xxv. 1-5). The confusion of names seems strange to us now, with whom lamp and candle enjoy such distinct individuality; but in old times, no doubt, the terms were interchangeable. Etymology shows the words to be derived from roots signifying to shine or burn—as, candela, καυδήλα, akin to *candeo*, to shine (Persian *kandeel*), (Sans. *kan*)—λύχνος, lucerna, from *lux*, light, (Sans. *lôk*), λάμπας, *lampas*, probably connected with *lame*, and the Hebrew *lapad*, to shine.

We are, I think, safe in concluding the torch to have been superseded by the lamp, and it is interesting to perceive how this is evidenced in mythology. Ceres, in the old legend, sought her daughter in Hell with a

torch; Apuleius makes Psyche drop hot oil on Cupid from a lamp. Whether candles, properly so-called, *i.e.*, wicks surrounded with coatings of wax or tallow, were known before or after the use of lamps had become general, I cannot say. We have a passage from Martial (1st cent. A.D.), in which the candle is mentioned as an old affair. Says he:—

"Nomina *candelæ* nobis antiqua dederunt,
Non nôrat parcos uncta lucerna patres."
(Ep. xiv., 43.)

But here he may mean torch—*funalia*—which the old Romans would most probably call *candela*, from its shining qualities, than *funalia*, in allusion to its manufacture. In the Greek, the word καυδήλα is derived from the Latin, and is not met with till the time of Athenæus, who lived in the reign of Aurelius and Commodus (about 150—220 A.C.) In his "Deipnosophistæ" we find one telling a waiter to bring farthing dips:—

ἐμοι δέ πᾶι δωρόιδειπνε ἀσσαρίου καυδήλας πρίω.

By this, no doubt, a rushlight is intended to be understood, which article had at that time come pretty generally into use.

But the most valuable information on this point is obtained from a passage in Apuleius' Metam. iv. where, at a noise in the dead of night, the household runs in with "*tædis, lucerna, sebaceis, cereis, et ceteris*," that is, with torches of pine, lamps, tallow candles, and wax tapers. This is a decisive proof that candles both of wax and tallow were used. They were, however, at no time considered as respectable as the lamp, for we find in another verse of Martial (Apoph. 42.)

"Hic tibi nocturnos praestabit cereus ignes
Subducta est puero namque lucerna tuo."*

An apology for giving his friend a wax light, as his footman has walked off with the lamp. At Herculaneum a chandler's apparatus was found, and in the British Museum there is a fragment of a huge candle found in Vaison, near Orange, and supposed to have been made about the first century, A.C. (Juvenal, iii. 287 also talks of the "breve lumen candelæ.") The wick of such candles would probably be the pith of rushes—*scirpus*—rudely covered with crude wax or tallow, and rolled into shape. Candlesticks to hold these existed, but later on with a spike to penetrate the butt of the candle. The name *candelabrum*, however, was applied generally to the pillar on which the oil lamp was placed, or from which it was suspended. I have here both diagrams and specimens of lucernæ and candelabra. This one especially deserves notice, as being a genuine bronze candelabrum, said to have been found in Herculaneum. The lamp upon it is a fair representative of its class, scarcely ornamental enough, perhaps, to be worthy of such a support, but the combination of the two will give you an accurate idea of a Roman house-lamp. I have given it a wick of oakum (*stuppa*), and filled the body with crude Italian olive oil, thus imitating, as exactly as may be, the actual light. Not a very brilliant one you will say, and smoking exceedingly. So did all old lamps of necessity, no attempt being made at creating the current of air requisite for proper combustion. You may imagine the state of a room the morning after a symposium, when, perhaps, a dozen lamps had been burning for six hours, smoking fearfully, without the least appliance for the escape of the heavy carbonaceous fumes. Indeed, it was one slave's recognised duty to go round in the morning wiping the sooty pictures and statues. The only instance, to my recollection, of a flue existing, was at the Erectheum of the Athens Acropolis. The lamp was of pure gold, and so large as to require replenishing only once a year. Callimachus designed it for the new temple, about 400 B.C., and provided it with a chimney, in the guise of a bronze palm tree inverted. Otherwise, the smoke appears to have been regarded as an unavoidable evil. Certain it is that, however magnificent and elaborate the design, the economy of the light remained stationary. A wick, sometimes of oakum, sometimes of the dearer Carpasian flax (cotton?) passed through the nozzle into the body, filled generally with olive oil; though, according to Pliny, bitumen was occasionally used. This is the less surprising, as Italy, in parts, is rich in springs of that mineral and petroleum. In the East, especially among the tribes dwelling in the vicinity of the Lacus Asphaltites, or Dead Sea, bitumen and naphtha were extensively consumed for lighting and other purposes. Perhaps *Nephi*, the sacred pit-fire, was of this nature; and, to speculate further, the emphasis laid upon the use of olive oil in the tabernacles of Israel may have been an implied condemnation of the mineral combustible, as peculiar to heathen ritual. Mr. Basil Cooper, the well-known Egyptologist, has kindly suggested to me a very fascinating etymology of the word *naphtha*—viz., NA, water; of

* Pliny xxxiv. 3-6, speaks of "the extravagant prices of candelabra, which take their name from *so poor a thing*."

PHTHA, the Hephæstos, or Vulcan of Egypt's deities, the god of fire. This is endorsed by the fact that the Indians, who sold the first petroleum as *Seneca oil*, and used it largely in their rites of worship, termed it *fire-water*, which name has descended to alcohol. About bitumen and its kindred we shall speak under the heading petroleum.

The introduction of lamps into Greece was gradual and slow. Probably, by the end of the 5th century B.C., they were in general use in the upper ranks of society. Herodotus (ii. 62), writing of the *Lychnokaie* (feast of lamps) at Sais, in Egypt (450 B.C.), does not express surprise at the lamps themselves, but only at the great number thereof. Their lamp differed in no way from that of Rome; the wick (θρυαλλίς) made from the woolly leaves of an indigenous plant, passed through the nose (μυκτήρ) into the crude olive oil. Those who wish to become more intimately acquainted with the various styles of ornament in vogue among old nations, will find every conceivable shape and size in the Etruscan Vase gallery at the British Museum, to which I must beg to refer them for further illustration. Becker's *Gallus* and *Charicles* also are replete with information on this point. I could not pursue the subject further, without trenching on the ground of my future lectures, in which the main subject will always be prefaced by an outline history of that branch. You will be surprised to find both our latter day inventions foreshadowed in extreme antiquity, and the imperfections of the dark ages maintained to a recent date.

It is worthy of comment, in conclusion, how fire and light have ever been invested with celestial attributes, and reserved for divine worship. I need only instance the Caspian fire-worshippers, and the Persian monarchs, with their silver fire trays borne before them into battle. Great festivals of lamps have been common to all nations. The *Lychnokaie*, above-mentioned as an Egyptian lamp-feast, has its parallel in the Chinese feast of lanterns. We send out annually many thousand scarlet candles, *lobchocks*—here is one—for this festival, which happens on the fifteenth day of the first month. Then the Greeks had their λαμπαδη-δρομία, and the Romans their *Lupercalia*. In lieu of this feast, remarkable for its licentiousness, Pope Gelasius instituted Candlemas, falling on the 2nd February. Some have it, that Vigilius supplanted the *Proserpina* by this festival. Anyhow, though the significance be changed, candles play the chief *rôle* in both. According to Pliny (Nat. Hist.), the Romans themselves used wax candles in certain rites. I need scarcely hint at the eternal lamp of Vesta, tended by damsels of established reputation; the never dying lights of Mahomet's tomb, Aaron's tabernacle, and Roman Catholic churches. The Romans lighted lamps in honour of Prometheus, who caught fire from heaven, of Minerva, who gave them oil, of Vulcan, who invented lamps; birthdays were sometimes called days of lamps, as the bulk of their gifts took that form, in cheap terra-cotta or costly metal; there was the *fax belli* or war torch, and *fax nuptialis*, the emblem of marriage.

> "There let Hymen oft appear,
> In saffron robe, with taper clear."
>
> *Milton*, ("Allegro").

On the tombs of the dead, lamps were placed by the sorrowing hands of their legatees, filled with scented oil. An oracular statue of Hermes, in Achaia, was "worked" by lighting a lamp before him, and placing a small coin at his feet.

Ingenious suggestions have been made about eternal lamps in tombs, which are positively averred to have been found burning after the lapse of centuries.

> "Our wasted oil unprofitably burns,
> Like hidden lamps in old sepulchral urns."
>
> *Cowper* ("Conversation").

Indeed, Rosicrucius gives a description of his eternal lamp, with all the circumstance of discovery. "But this," says Disraeli, "is only dwelt on to make it appear that he did discover something." Boyle undertook a series of experiments with the air-pump, which demonstrated the absurdity of such statements. Reserving my private opinion as somewhat iconoclastic, I might suggest the possibility of an asbestos wick, communicating with a supply of light naphtha, burning indefinitely in a tomb not absolutely air-tight. Possibly, also, highly carbonaceous vapours in the sepulchre might have been kindled by the intruded torch.

After this hasty glimpse at our wretchedly illumined forefathers, you will be more than ever inclined to endorse Lamb's opinion, that "one can never hear mention of them without an accompanying feeling, as though a palpable obscure had dimmed the face of things, and that our ancestors wandered to and fro—groping."

Miscellaneous.

ECONOMIC PLANTS IN THE CEYLON BOTANIC GARDENS.

The Director of the Botanic Garden, Péradéniya, Ceylon, has issued his report for the year 1882, containing a record of good work done in that part of the world. It is under the head of "Economic Plants" that the most valuable information is found. Coffee receives, as might be supposed in Ceylon, the first consideration, and on this subject Dr. Trimen says:—

"Leaf disease has in no degree diminished, and the continued failure of crop during the past year has added to the difficulties of all concerned in the planting enterprise of the colony. No combined effort whatever to prevent the disease on the lines indicated by its known nature has been even attempted, whilst the waste of money and time in local applications of 'cures' has continued. As, at the same time, high cultivation and liberal manuring have become generally impossible from pecuniary necessities, the existing state of things, however much to be lamented, cannot be considered surprising.

"A remarkably wet season, too, has aggravated the condition of the badly nourished trees, and the low prices ruling for coffee have intensified the loss by short crops. Thus the cultivation of coffee has been, in many places, found not to cover expenses, and the necessity of growing other products has been more than ever forced upon proprietors.

"The Planters' Association, having called the attention of Government to the serious ravages of 'grub' in several of the coffee districts, and requested that a naturalist might be appointed to aid the planters in devising remedial measures, I have suggested that if the association would draw up a succinct and plain statement of the points in connection with the subject, which still required elucidation, I would endeavour to obtain the opinions of a skilled entomologist of reputation upon them. It may be hoped that, as nothing more is required in such an investigation besides careful and sustained observation, full and accurate information on the life and habits of these coleopterous larvæ (chiefly cockchafers) will be forthcoming from the association. I fear, however, that with reference to any remedies that might be suggested, the same want of co-operation will be met with as in other similar cases. It is a fact that there are some gentlemen here who, in opposition to the agriculturists of every other country, maintain that these larvæ do no harm whatever, as they feed only on the rootlets diseased or decayed. It is obvious that persons guided by such notions could seriously hinder any plan that might be recommended.

"*Liberian Coffee* has had to bear severe attacks of leaf disease, and rises and falls in planters' estimation, yet in suitable soils and localities it does well, and the old trees in Péradényia (now eight and nine years' old), though badly diseased, show no marked diminution in their crop-bearing capacities; they are, however, regularly manured. I regret to find that it is not possible to ascertain the exports of this coffee from Ceylon, as it is unfortunately not distinguished from other 'plantation' in the returns.

"The gratis distribution of seedlings to native cutivators, the Government agent has continued, and I have drawn up a short paper of simple instructions for planting and cultivation. This has been printed in the vernacular, and distributed with the plants. We have at Henaratgoda far more seeds and seedlings than are applied for, and I should be glad if a more general distribution could be carried out.

"*Cinchona.*—The enormous advance in the cultivation of cinchona fully justifies one in considering it, at present, as the foremost product of Ceylon. In some of the older districts, *C. succirubra* is, on numerous estates, now completely supplanting the coffee, which is allowed gradually to go out of cultivation as the former grows up amongst it. During the year ending September last, as much as 3,099,895 lbs. were exported, being an increase of 1,892,175 lbs. over that for the previous year, or considerably more than double. It has, however, to be allowed that a large quantity of inferior bark has gone into the market. The position at the end of the year may be well seen from the following, extracted from Messrs. Rucker and Bencraft's *Weekly Circular*, dated 21st December, 1882. 'The shipments from Ceylon are very heavy, and altogether beyond what was at present expected, but they are also somewhat deceptive. A very considerable proportion of these barks are twigs, scrapings, weak branch, &c., barks, which in bales appear important, and affect statistics, but from a sulphate of quinine point of view of little value. Also, much young bark is being sent forward, and for these reasons we think that those who study the position of this market must be careful not to turn round now and overestimate the production in Ceylon.

* * * * * *

Ceylon barks were, as usual, catalogued to be sold at market prices, and a fall of 15 to 20 per cent. was at once established. Some barks sold well and apparently at full prices, but these were invariably barks containing a heavy per-centage of cinchonidine, orders for which alkaloid had been received.'"

Dr. Trimen says, "That so long as quinine retains its supremacy, only the rich barks can secure good prices, whilst the inferior ones must hang on hand, and only be sold at reduced rates. There is little or no fear of an excess in production of bark of the best qualities here, but it is otherwise with the poorer sorts, and it is with these, from the planting point of view, production may be overdone. On this account, in growing quinine, quinine bark planters

will do well to go in for the best kinds only. Of these, *C. Ledgeriana* still remains by far the most desirable, but it cannot be grown at high elevations. It is, however, at the same time pretty evident that we are approaching the time when the almost exclusive estimation of quinine must give way before the evident advantages of employing the mixed alkaloids. The great philanthropic idea which led to the acclimatisation of these trees in the East—the provision of the blessing of the cheap febrifuge to a fever-stricken population—must be carried to its issue, in spite of any interested efforts to delay it. The practical efficiency of the imperfect preparation made by the Indian Government, now well established, has shown the way to a vast development of the use of similar and improved preparations. Foreign manufacturers have already appreciated the great market opening before them (thus the Zimmer manufactory at Frankfort-on-Maine makes vast quantities of sulphate), and growers should not be unprepared for the change. This, when it comes, will not be disadvantageous to Ceylon planters, with their large acreage of *C. succirubra*, the proportional value of which, to other barks, will rather be increased."

Dr. Trimen draws attention to the great demand that exists in the East for a febrifuge drug, and quotes the following extract from the report of the British Consul at Kanagawa, Japan:—"That the consumption of quinine is not so large as might be expected, is due to the fact that the bulk of the population in Japan are too poor to pay for such an expensive drug, and the cheaper cinchona alkaloids are sold in place of it. English made quinine does not appear in the market; that principally imported is prepared in Milan; then comes German, and after that, Pelletier's muriate of cinchonine, which is imported in large quantities. The Japanese prefer goods of English preparation, and if manufacturers comply with the requirements of this market, it will doubtless prove to be an important outlet for their goods. It should, however, be borne in mind that they have powerful competitors in German merchants, who, in addition to their well-known scientific attainments in the manufacture of chemicals, are now turning out articles of quite as good a quality as those coming from England, and, in many cases, at very much lower prices."

There is, it is stated, a large consumption of cinchona alkaloids in Ceylon, and Dr. Trimen expresses his opinion that a local manufacture of mixed cinchona alkaloids, under efficient management, in Ceylon, might prove to be of great value.

It seems that the practice of shaving off the rich outer portions of the bark down to as near the cambium zone as possible has become very general. It is found to be simple and easily learnt, expeditious, cheap, and very convenient for drying, packing, and baling for shipment. As a consequence, it has nearly superseded other modes of bark harvesting. The practice is applied to all the kinds grown, and, as a rule, the trees do not appear to suffer much, if the operation be carefully performed; new bark is rapidly formed, and the amount of quinine is much increased in the renewed tissues. The scraped surface is usually covered. The common mana grass (*Andropogon Martini*) which is readily obtained, and is durable, is chiefly used for the purpose. Renewal, however, occurs without any covering, except in very dry weather. Dr. Trimen says it is regrettable to see such very young trees (saplings of eighteen months even—scarcely three-quarter-inch in diameter) subjected to this process, with the accompanying pruning off of all side branches, and the short intervals allowed between successive shavings. A small gain is derived at the time from such procedure, but it is no doubt wasteful in the long run. Dr. Trimen says he has noticed many young trees succumb to the treatment, and in any case, he thinks it must greatly check their growth, impair their vigour, and shorten their life. "Experiments, however," he says, "are greatly needed, to determine several points in connection with this subject, especially as to the ratio of the increase of alkaloids in renewed bark to the age of the tree, the best period to allow to pass between successive shavings, &c. It is much to be desired that gentlemen who have the opportunities would carefully conduct such investigations upon their estates; and it would be in such cases that, in my opinion, the assistance of Government, in obtaining for it the necessary analyses for the general good, might be fairly asked for."

The bark taken from a few old trees of *C. succirubra* at Hakgala was sold in Colombo in December. The trees were in all probability some of those raised from Spruce's original seed received in Ceylon in 1861, the young plants from which were planted out in 1863 in the wild jungle, in accordance with the views then accepted as to their requirements. Though the oldest, these were not the largest in the island; one stem girthed 37 inches near the ground and 24 inches at five feet above it. This tree gave 77 lbs. of wet bark (25 lbs. when dry), and most of this was fine quill. The handsome trunk bark of these trees was locally analysed for sale purposes, and yielded 5·62 per cent. total alkaloids, 2·41 per cent. being quinine sulphate.

The trees of *C. Ledgeriana* barked at the same time at Hakgala, were small and not three years old. The local analyses of this bark showed 2·63 per cent. of quinine sulphate, and 4·53 total alkaloids. A number more of these remain at Hakgala, but are dying out steadily. The high elevation (over 5,600 feet), shallow soil, and wet sub-soil are insurmountable obstacles to the cultivation. Taking these local disadvantages into consideration, the above analysis of such young trees is satisfactory.

On the subject of the well-known Cuprea bark, Dr. Trimen says, "After much trouble, seed has been obtained, at Kew, of the 'Cûpra Quina' tree, affording the 'Cuprea' bark, imported during the last two or three years to the London market (*viâ* New York) in such vast quantities. A little of this seed has been sent to me; it was collected from trees

growing between 5,000 and 6,000 feet at Landasugi (U.S. Columbia), and sent from Bogota. No time was lost by me in forwarding this to Hakgala, but I regret to say that only two seeds germinated, of which one subsequently died, so that we have now but a single seedling of this interesting plant. Mr. Triana has identified the Cuprea bark trees as species of *Remijia*, a genus nearly allied to *Cinchona*, so that it is no longer possible to consider the febrifugal alkaloids exclusively produced by the latter. The analysis of the better sorts of Cuprea bark average 1·8 to 1·9 of quinine sulphate, rarely reaching 2 per cent.; but some varieties are almost worthless. Manufacturers, however, prefer it in consequence of its freedom from cinchonine, and the readiness with which it pulverizes. There are many varieties, and some grow at a much lower elevation than that above given; it is thought such may do in low coast districts.

"*Tea.*—The past year has witnessed a very striking rise in the export of tea. No less than 345,702 lbs. more in the year ending September, 1882, than in the previous one, the whole quantity shipped being 623,292 lbs. Tea estates have been opened at all elevations, from near sea level up to the highest available land in the wet districts, and many old coffee estates, not suitable for cinchona, are now cropped with tea. This article has thus stepped into the second place, and with cinchona, has gone a considerable way towards compensating for the serious diminution in coffee. In connection with tea, I may mention that an excellent wood for boxes is that of *Cedrela Toona*, a large tree with a wide geographical range in tropical Asia, but not native to Ceylon. The few trees in the gardens give an abundance of seed, and it has the advantage of growing very quickly. Thus seedlings at six months measure 10 feet high, and in trees seven years old the circumference of the steam, one foot above the ground, is 4 feet 10 inches. The wood is light, strong, clean, non-resinous, and not attacked by insects.

"*Cacao.*—There is every prospect that this article will play an important part in the future of Ceylon cultures. The year ending with September, 1882, saw 1,018 cwts. exported, against 479 cwts. in the previous one; and what is more satisfactory is that the prices secured show that our product is of the best quality and esteemed in the market. In the lower hill districts are many old and more or less abandoned coffee estates, and on not a few of these cacao is being successfully grown, if only due care be taken in first planting, and protection from wind afforded during the first two years.

"*India Rubber.*—In continuation of my previous reports on the South American rubber-trees: I have now to record a considerable step in advance. Samples collected from each of three species have been submitted to the best commercial authority in London, and the reports received are very encouraging, so far as the quality and value of the product is concerned. In no way does the rubber fall short of that from the wild trees. A tapping of Ceara (*Manihot Glaziovii*) was made at the end of April (dry weather), and about 20 oz. of dry rubber were obtained from nine or ten trees. One of these afforded 4 ozs., whilst another, which had been bled to the extent of 2 ozs. the year before, gave scarcely 1 oz. The process followed consisted merely in peeling off the dry parchment-like outer bark, and making short slanting cuts with a sharp knife on the green surface exposed. The milk flowed most freely in the early morning. I, at first, experimented with a small axe purposely constructed with a sharp cutting edge, prevented from penetrating too deeply by a projecting shoulder, but this did not answer so well as an ordinary knife. The milk which trickled down the stem was allowed to remain there till it solidified, when the strings were pulled off and rolled into balls. By this means a generally clean and dry sample was secured; a portion, however, afterwards acquired a somewhat sticky consistence, along with a slight admixture of sand, contracted by dropping on to the soil at the foot of the tree. I separated this from the rest, and submitted both to Messrs. Silver for report in June. They valued the dry and clean portion at 2s. 9d. to 3s. per pound, a high price for "Ceara scrap;" the sticky portion, which could not be properly washed and analysed, was not considered worth more than 1s. to 1s. 3d. per pound. The importance of taking care to secure a clean, dry rubber, is very evident.

"The value of Ceara rubber being now assured, it may be expected that planters (some of whom have now a large stock of trees) will institute experiments as to the method which will secure the largest quantity of milk per annum, or during the life of the tree.

"The *Castilloa* trees both at Péradéniya and Henaratgoda have flowered during the year, but a single tree only (at Péradéniya), ripened any seed. Two fruits were matured in June, from which fifteen seeds were obtained; of these nine germinated on the thirteenth day after sowing, and have grown rapidly.

"It is hoped that a larger quantity will be produced during 1883. The trees are now six years old; the largest at Henaratgoda is about 46 feet high, and 26 inches in circumference at a yard from the ground, an increase of $3\frac{1}{2}$ inches in girth during the year. *Hevea* has not flowered at Péradéniya. The plantation at Henaratgoda has been thinned out, in the hope of more sunlight leading to a larger production of flowers. Our largest tree there is now about 50 feet in height, and at a yard from the ground measures $25\frac{1}{2}$ inches in girth, $4\frac{1}{2}$ inches more than last year.

"An experimental bleeding of both *Hevea* and *Castilloa* was made at Henaratgoda in October. Five of the *Hevea* trees were prepared by scraping off on one side the rough surface of the outer bark; a few short cuts with a knife were then made, and the rubber allowed to dry (as in Ceara); the strings were rolled

off into a ball, which weighed somewhat over 2¼ ozs. Only two *Castilloa* trees were slightly bled in the same way, the sample ball obtained weighing above 3 ozs. Both samples were perfectly clean, and were forwarded to Messrs. Silver for report in November. This (dated 8th December, 1882) was received in January, 1883. The *Hevea* rubber was found to differ chemically in no respect from the better descriptions of Para bottle-rubber, but the ash was about one-half only. 'As far as can be determined on so small a sample, there is reason to believe that as regards strength and elasticity it would be fully equal to good Para India-rubber.' The market value was estimated at 4s. per lb.

"The *Castilloa* sample was found to become on drying much darker and shorter than the Para. This shortness 'would restrict its use to some slight extent when tensile strength or tenacity is required. When mixed with usual proportion of sulphur and heated, it vulcanises well, but imperfectly, and is devoid of strength—characteristics of the better kinds of rubber. Nicaragua rubber is not at present met with in this country to any great extent; but there is no doubt that the purity and general qualities of this sample gain for it a favourable reception even if our supplies from present sources were more adequate to our demands. The chemical analysis of the ash of the Castilloa shows that there is no very marked difference in the mineral constituents of the pieces of the Hevea and Castilloa under the present system of cultivation.'

"This is most encouraging, and it may be expected that the Indian Governments will be stimulated by it to seriously take up the cultivation of the American rubber trees.

"All the climbing caoutchouc plants, *Landolphia* (including *Vahea*), *Urceola* (including *Chavannesia*) and *Willughbeia*. grow very much better at Henaratgoda, than in the Péradéniya garden, which is at too high an elevation for them; *Landolphia florida* succeeds best in the latter (now nearly three years old), is fully three-fourths of an inch in diameter. The milk of this species I find to be extremely thick, solidifying with rapidity into a very tough elastic rubber; it should be a very rough sort, but will be difficult to collect. The *Urceola* (*Chavannesia*) *esculenta*, which completely failed at Péradényia, has made astonishing rapid growth in the tropical garden, where, in the course of a few months, it has completely covered trees of considerable size, with its long close twining stems."

Amongst plants yielding valuable drugs, Dr. Trimen reports the cultivation, in Ceylon, of jalap, dandelion, rhubarb, belladonna, henbane, foxglove, and camomile, and amongst condiments and other useful plants, experiments are being made with Cassia Lignea, Star anise, Mysore cardamoms, pepper, sago palms, the Brazilian wax palm or Carnauba palm (*Copernicia cerifera*), and the wax palm of the Andes (*Ceroxylon andicola*).

EUCALYPTUS TREE IN THE ARGENTINE REPUBLIC.

Consul Baker, of Buenos Ayres, says that the *Eucalyptus*, styled by some the "fever destroying tree," is considered to be a very healthful tree, and the pungency of its leaves is such that it is never molested by insects; it is reported to be the only tree grown in the Argentine Republic which the locusts will not attack. It has the reputation of being an effectual destroyer or absorbent of malaria. In Australia, it is said, there are no marsh fevers where large forests of the *Eucalyptus* exist, and the trees have been planted in the Pontine marshes near the City of Rome, with excellent effects. In Buenos Ayres they bruise the leaves and bind them to the forehead for nervous headache. The leaves themselves are a special abhorrence of such insects as prey upon fruits and fruit trees, against whose visitations they furnish protection by being scattered thickly on the ground underneath. Consul Baker is strongly in favour of introducing this tree into the majority of the European countries, and into the United States, and calls attention to the success which has attended its cultivation in certain districts of France, Italy, Spain, and Portugal. The tree has been planted on a large scale and with good results in Algiers, and at the Universal Exposition of 1867, in Paris, the trunk of a tree only eight years old, having a circumference of between five and six feet, was exhibited. The *Eucalyptus globulus* grows with a rapidity which is surprising. The first year of its planting, its usual growth is about 18 inches per month, when it is planted under favourable circumstances. Its increase in height is somewhat retarded during the second year, but the diameter of the trunk increases, and its branches begin to spread. Owing to this rapidity of growth, forests of these trees are obtained in ten years, which with other trees it would take a century to form. As an example of their increase, it may be stated that in Hyères seeds planted in 1857 had, in 1865, reached the height of 58 feet. In Toulon, the plants grow to 24 feet in two years. In 1863, there were trees in Algiers of three years' growth, which had attained a height of from 30 to 35 feet, and generally in that country they grow at the rate of about 10 feet each season. In Australia, its native soil, trees of fifty years' growth attain an altitude of from 225 to 280 feet, and circumference of from 50 to 60 feet, producing colossal boards or slabs 160 feet long and 12 feet wide. In the Argentine Republic, the tree has a perfectly straight trunk, and in the forests the branches rarely begin below 60 or 70 feet. The outside bark is loose and shaggy, like the plane tree. When young, the trunk is full of small branches, filled with bluish green leaves. In the first years of its growth the leaves are opposite and sessile, but as the tree assumes its true character, they become petiolate and alternate, and their colour changes to a much darker hue, hanging

vertically, and presenting their edges to the sun. Their two surfaces are exactly alike; the flowers are white, and produce a capsule-seed vessel of the size of a filbert, which is full of small black seeds similar to those of the onion. The tree will not grow from cuttings, it must be produced from the seed. These are generally planted in boxes, and afterwards transferred to small beds. Two or three seeds are generally planted together, and lightly covered with fine earth or river sand, and afterwards finely cut straw is strewn over the top, as much to protect them from the hot sun as from heavy rains. In very dry seasons the small plants are watered every fifteen days, but this is not absolutely necessary. The tree requires a deep soil and permeable, neither too light nor too compact, and it does not grow to advantage when there is too much humidity in the earth. The usual time for planting the seed is in the months of February and March. The seeds begin to sprout in eight or ten days. The cultivation of the *Eucalyptus* in the Argentine Republic has only two difficulties to encounter, the first being the irregularity of the seasons. A hard frost out of season, which sometimes occurs, may destroy a large number of plants. It is, however, very rarely that trees that have safely passed the first winter will afterwards be killed by frost. Although the tender shoots may suffer, the tree, for that reason, does not die, but with the first favourable weather new and stronger shoots will spring up. After having changed their leaves, the trees appear to be able to endure greater cold. The other difficulty with which they have to contend is the wind. On account of their rapid growth, the trees become top-heavy with their weight of leaves; and the roots for sustaining such an enormous pressure as a high wind produces are relatively small, so that a south-west *pampero*, especially after a rain storm, will sometimes uproot whole plantations, and this is particularly likely to happen during the second year of their growth. To provide against this, planters in Buenos Ayres make use of stakes and supports to guard against the danger to which the trees are exposed. When the trees are placed close together, they assist to protect each other, and when they are planted under the lee of a belt of timber, which is frequently done, they are better enabled to resist the wind. After the third year they are thinned, and those thus cut away are used as stakes or guards for the rest.

Obituary.

Duke of Marlborough, K.G.—The Society has lost in the Duke of Marlborough another distinguished Vice-President, who had been connected with the Society for nearly thirty years. John Winston Spencer Churchill, seventh Duke of Marlborough, was born on June 2nd, 1822, and was educated at Eton, and Oriel College, Oxford. He was member of Parliament for Woodstock from 1845 to 1857, with the exception of a period from 1845 to 1847, when Lord Alfred Churchill sat for that borough. In the House of Commons his name was more particularly associated with "The New Parishes Act," which is known as the Marquis of Blandford's Act. He succeeded his father as Duke of Marlborough in 1857, and in subsequent years he held several important offices in the State. From December, 1876, to May, 1880, he was Lord Lieutenant of Ireland, a position which had been offered to him, in 1874, by Mr. Disraeli, but which at that time his Grace felt himself obliged to decline. He was a Prince of Mindelheim, in Suabia, of the Holy Roman Empire, an honour originally conferred upon the first Duke of Marlborough, and Lord Lieutenant of Oxfordshire. The Duke's death, which was very sudden, occurred on Thursday, the 5th inst., at his house in Berkeley-square.

General Notes.

Telegraphs in Europe.—The following Table gives, according to statistics published by the European Telegraph Bureau, the numbers and length of electric telegraph lines in the various countries of Europe, with the number of inhabitants to each office in the principal countries:—

Country.	Number of lines.	Total length. Miles.	Inhabitants to each office.
Germany	10,308	161,954	4,388
France	5,885	140,436	6,342
Russia	2,731	138,902	27,091
Great Britain	5,600	122,856	6,294
Austria	2,604	57,522	8,504
Italy	2,470	56,235	10,850
Hungary	1,069	34,083	—
Spain	385	25,315	43,358
Sweden	788	18,565	5,794
Belgium	827	17,350	—
Switzerland	1,139	10,040	—
Norway	260	9,693	7,411
Holland	418	8,782	—
Portugal	202	6,644	—
Roumania	206	5,382	—
Denmark	387	5,250	—
Greece	100	2,867	—
Servia	60	2,569	—
Bulgaria	37	2,113	—
Bosnia	69	1,976	—
Luxemburg	64	395	—

Journal of the Society of Arts.

No. 1,600. Vol. XXXII.

FRIDAY, JULY 20, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

As already announced, the Conversazione will be held on Wednesday next, the 25th inst., at the Fisheries Exhibition. Invitation cards have been issued to all the members of the Society.

The doors will be opened at 8.30, at which hour the reception by Sir William Siemens (Chairman) and the members of the Council will commence.

Their Royal Highnesses the Prince of Wales, President of the Society, and the Princess of Wales, have intimated their intention to be present.

It is hoped that the members and their friends will distribute themselves about the buildings and gardens, so as to prevent local crowding.

The gardens, as well as the Exhibition Buildings, on this occasion will be lighted by the electric light.

The Band of the Grenadier Guards and the Band of the Royal Artillery will perform either in the Building or in the Gardens (according to the weather).

The Band of the 6th Thuringian Regiment of German Infantry (by kind permission of H.R.H. the Duke of Edinburgh, Honorary Colonel of the regiment), and the Hungarian Band, will perform within the building.

A vocal and instrumental concert, consisting of glees, &c., will be given in the Conservatory, from 9 to 11 p.m.

The only entrance to the Exhibition will be that in the Exhibition-road.

*** Evening Dress, but there will be no arrangement for receiving hats, coats, cloaks, &c., as part of the entertainment will be in the gardens.

NEW MEMBERS OF COUNCIL.

The vacancies on the Council caused by the death of Mr. Spottiswoode, and the inability of Admiral Ryder to attend, have been filled up by the Council, in accordance with the bye-laws, by the election of Admiral Sir Edward Inglefield, C.B., F.R.S., and Mr. W. G. Pedder.

Proceedings of the Society

CANTOR LECTURES.

SOLID AND LIQUID ILLUMINATING AGENTS.

By Leopold Field, F.C.S.

Lecture II.—Monday, February 5th, 1883.

Adhering to the plan of commencing *ab ovo*, we will apply ourselves in this lecture to the study of those substances which can be used for illumination in a crude manufactured form, or, rather, with unchanged chemical composition. Tallow, bees-wax, and sperm-wax are the chief of such naturals, and we will discuss them accordingly.

I have already referred to the distinction drawn by Apuleius between *cerei* and *sebacei*; also to the fact of wax candles having entered into certain rites of heathen worship. Partly from the smaller supply, chiefly though, no doubt, from the superiority of its appearance, hardness of grain, and sweeter odour, the wax candle has ever lorded it over the unsavoury tallow dip, associated with kitchen and garret, while the wax taper suggests cathedral and boudoir. In days before gas and Argand lamps, people's rank was not unfrequently gauged by the class of candle they affected. "Wax candles in the school-room!" says Mrs. Elton, in "Emma." Lord Bacon, in his "Natural History," extols wax lights as lasting longer than tallow candles, because "wax is more firm and hard." Tallow, however, can never be regarded as a good illuminant. Look at this clumsy apparatus of tray and snuffers, with the candle guttering in long winding

sheets, every drop on the brass candlestick being marked by a green spot of "verdigris" (stearate of copper); and the long red point of the unconsumed wick protruding from the dull brown flame, exhaling nauseous odours, both from unburnt and burnt tallow. One would have imagined that such a candle would have fallen a victim to popular execration when Chevreul and Young provided their cheap and beautiful substitutes. But no, tallow candles are still burnt in tons—miners, cobblers, and other traditional craftsmen adhere to the light of their fathers—and so we cannot avoid entering into the details of their manufacture. It may be, perhaps, that the recommending qualities of tallow to certain classes are, the readiness with which it adapts its form to circumstances, enabling it to be stuck into any crevice, without bending, as cheap paraffin will, and the large wick, keeping alight in draughty places, and giving a bulky flame, without much smoke.

Referring to old manuals of candle-craft, I find blendings of tallows recommended; certain proportions of beef and mutton fat. The best brand for the purpose is known as P.Y.C., which, I believe, means Petersburg Yellow Candle (tallow implied). This article has lost its prestige of late years by the enormous imports of Australian substitute, and now appears to serve rather as a basis of speculation than in any commercial capacity. However, the tallow should naturally be as hard as possible, without risk of cracking, which result can only be attained by experienced selection. The fat from various portions of the animals is rendered, *i.e.*, boiled well with salt (or acid) water till the fibrous portions have settled out, and the tallow swims white and sweet on the top. Of this, with no more ado, candles are made. A truly ancient form of tallow candle is the rushlight. As it is now, so it must have been thousands of years ago; it being impossible to figure a more primitive stage of existence than you see here. A rush, deftly stripped of its skin, of which a slender streak is left to act as a kind of backbone to the tender pith. A number being thus prepared, are allowed to become thoroughly dry, by hanging in an airy loft. They are then tied by the tops in little bundles of four or six, which are held in the hand, being kept apart by the intervention of the fingers. Thus disposed, they are discreetly immersed in the tallow, of a temperature just high enough to preclude solidification in bulk, yet to ensure a sufficient portion adhering to the cold rushes. After two or three dippings, the candle is complete. It remains now to let it harden and whiten, to which end it returns to the aforesaid loft, and in about a month of favourable weather is ready for sale. I had considerable difficulty in obtaining these specimens of rushlights, although my inquiries were made in the most out of the way country places. In Hampshire, I came across this instrument, which is really interesting, and which I am told is still used in the Isle of Wight farms. A small deal strip is stuck upright at angles to a broader piece of wood, which acts as a firm basis. The upright board is furnished at the top with a rude iron clamp, which holds the long rush, dipped once or twice into grease. The rush, as you see, is held at an angle of 30° to the basis, on which the end rests, the ash dropping on the table. A more primitive candlestick and light cannot be conceived. But the rushlight itself I found, singularly enough, in the heart of London, where, imprisoned in a tall gauze shade, it still illumines, in perfect safety from fire, many a humble sick chamber. One very good quality of this light is the absence of snuff; the wick consuming as it reaches the air, leaving nothing but a slight feathery ash.

I cannot say when cotton wick was introduced. Oakum (*stuppa*) and papyrus (*scirpa*) were the ancient substitutes; but most probably, with us, the wicks were made of linen, gradually giving place to cotton, as that material became more familiar. All candles were "dipped," "rolled," or "poured," till the Sieur de Brez, in the 15th century, introduced the "mould" candles, which rapidly asserted a position of superiority. Of these we cannot speak till the last lecture, and with regard to dipping, not much remains to be told. The principle remains the same; but the pressure of increased consumption concurring with superior mechanical skill, brought about several improvements in the method of working. The wicks were hung on hoops, and a row of three hoops on one arm of a revolving wooden star, so contrived that only three hoops at a time should pass over the kettle. Once in position, the craftsman depressed the arm with the three hoops pendant, which were withdrawn, on release, by the antagonistic weight of the opposite spoke. So with all the arms in rotation, and by the time the first came round again, the candles would be ready for another dip. The whole arrangement was suspended to one arm of a scale beam, which indicated when

the candles had attained the legitimate thickness

This was a great saving of labour, but still each individual wick had to be cut and fastened to the hoop. A good method of obviating this is shown in this retangular iron frame. To one corner I fasten the end of a wick on this reel. Adjusting the frame to a simple revolving appliance, I turn the handle rapidly, and you see the wick wound upon the frame. It is then secured tightly by a little clamp at either end, and a number of these frames adjusted to the revolving spokes already described. After one immersion, the wicks are rigid enough for independent action. Accordingly, a sharp knife is drawn along either row, at the base. Now, you see, the rudimentary candles swing loose, the lower parts of the frame is removed, and the dipping proceeded with *en règle*.

Another form of tallow candle is the "flat candle," a kind of twin, or two candles joined side-ways, and flattened. This is much affected by cobblers, for no reason that I can see, except as alleged by a sutorial interlocutor of long experience, that it gives twice the light of an ordinary candle—in which, as it has two wicks, there is, perhaps, nothing remarkable.

The great fault of tallow candles, dips or moulds, is their tendency to gutter, and to exhale evil odours when blown out; also, the necessity for snuffing them. The first two vices are ineradicable, lying at the root of the composition of tallow itself. Being a mixture of hard stearin and soft elaidin, the latter melts first, and consequently overruns the hard cup formed by the former, producing the domestic phenomenon of "winding sheets." Again, each of the commixts is a compound of fatty acid, stearic and elaic, with glycerine. This combination has to be split up, which operation, consuming heat, dims the light to begin with; and the malcombustible glycerine is vapourised as *acrolein*, a highly pungent compound. It remained for Chevreul to purge the candle from this abomination; Mr. Palmer, however, took the wick in hand, and, by a happy invention, rendered snuffing unnecessary. He introduced a fine thread (technically called "the doctor"), impregnated with impalpably powdered bismuth, into the body of the wick, which, further, was not twisted after the ordinary fashion, but consisted of a number of parallel threads bound together by another one wound round them. The bismuth fuses into a little ball, the weight of which draws the wick laterally out of the flame into contact with the air, having performed which duty, the bead oxidises, and volatilises away. Here you have one of "Palmer's Metallic Wick Candles," burning side by side with an ordinary dip, and the difference in burning renders comment superfluous. Mr. Palmer has very kindly supplied me with a number of wicks and candles of different structure and for various purposes. In this large candle there are three convolute wicks. These were wound spirally round a rod, clamped at the top; the rod introduced into a mould, as here shown—the mould then filled with tallow, and allowed to cool, when the rod was withdrawn, leaving the wick round a tubulated passage up the centre. This kind of candle was much used in the candle lamp, of which I have here a very old specimen. You see the three wicks, untwisting as they burn, each with its bright little head. The flame is large, but, owing to the reasons alleged before, not luminous in proportion.

Later on, I hope to give you some numerical values of the luminosity of candle flames, which will show you the great difference in the burning of stearin with, and stearic-acid without, glycerine.

We have talked enough of tallow now, and shall discover nothing more to its advantage. By pressure, the softer elain may be, to a great extent, removed; look at this brilliant, blue-white substance, which you would hardly know to be tallow; and, again, at this mould candle made from it, burning without guttering, and with a metallic wick. Still the light is dim and the smell evil. In our fourth lecture you will see, though, how the coarsest tallow can be made, by the chemists' art, to rival paraffin in brilliancy of light, spermaceti in whiteness, and wax in cleanliness, sweetness and hardness.

Wax next demands our consideration. Here I must call your attention for a moment to the manner in which I have divided the various substances that subscribe to the definition of fats. This is quite arbitrary on my part, but I am emboldened by the fact that every authority on the subject has followed his own ideas, and given his own definitions. Fats proper, I think, are such bodies as yield glycerine upon saponification. According to this definition, very few of the bodies we shall have to discuss can be called fats. But I have given the word a broader signification, and propose to extend the name to embrace all substances which possess both lubricity and inflammability, and leave a more or less per-

manent transparent stain upon paper. By taking for the nonce, this view, we are enabled to include the paraffins, olefins, and waxes; also turpentine and camphor, with their isomeric essential oils. Oils themselves have long been divided into *fixed* and *volatile*, the latter being also termed *essential*. With these we have nothing to do; they are all isomeric either with turpentine, as lemon, bergamot, orange, and many other well-known essences; or with camphor, as rosemary, lavender, rue, and that class of perfumes. Turpentine and camphor may have to be mentioned in the lecture on lamps, but quite *en passant*.

The term *wax* used to be applied solely to beeswax, but of late years the introduction of paraffin, solid and liquid, has led to the name being employed to distinguish the first, paraffin proper, from the oil. So the white solid rejoiced in the designation, "paraffin wax," until the cognomen being dropped altogether, we find certain companies advertising their goods simply as "wax candles," a confusion of names which must be deprecated, as tending to mislead; perhaps, however, this is the end in view.

Wax may be defined as bodies of a certain viscid plasticity when warmed, consisting of fatty acids of the series $C_n H_{2n} O_2$, either free, or in combination with an alcohol radicle; they do not yield glycerine upon saponification, which is effected with difficulty, and the soap formed is sparingly soluble in water. Following these lines, we have the following genuine waxes of interest to us:—

		Origin.
Animal	Bees-wax	*Apis.*
	Spermaceti ..	*Physeter macrocephalus.*
	Pih-la	*Coccus sinensis.*
Vegetable	Carnauba wax.	*Copernicia cerifera*
	Myrtle ,,	*Myrica cerifera.*
	Palm ,,	*Ceroxylon andicola*
	Japan ,,	*Rhus succedanea.*

We will take these seriatim. *Beeswax* is the gift of the ordinary bee. It has long been an open question whether the wax was in the pollen of the flower, the bee acting as a mere vehicle, or whether the insect evolved the wax by some process best known to itself. When, on experiment, it was found bees who were fed entirely on sugar continued to produce wax, the question was considered settled; namely, that the wax was as genuine a bee product as the silk of the worm. But later investigations show that, after two or three days sugar diet, the bees fail to supply any more wax, and ultimately die. Carefully considering all I have been able to find upon this subject, I am inclined to think that pollen is necessary for the formation of wax; in the first place, it nourishes the bee, containing nitrogen, which sugar does not; and, secondly, itself containing wax, probably gives the initiatory to the wax-producing organs. It is a fact, that a colony of bees, deprived of pollen, will take eighteen ounces of honey to produce an ounce of wax; whereas, with a proper supply of "bee bread," only fifteen ounces will be consumed in making the same quantity. The wax exudes from between the lower rings on the abdomen of the bee, and is worked up between the fore-paws, for though of high melting point (145° F.), it becomes plastic at 90°, and can be readily moulded. The composition of beeswax has been fruitful subject of discussion among chemists, who have obtained results of startling discrepancy. This is, doubtless, due rather to the adulteration of the wax before analysis than variation in the substance itself; it being generally found that substances of animal origin are very uniform in composition. Mr. Otto Hehner has recently made a most exhaustive investigation of a great number of different waxes, and comes to the conclusion that the average composition is—

Cerolein	(?)
Myricin	·88
Cerotic acid	·12
in	100 parts of wax.

These two constituents may be easily separated by boiling the wax with alcohol, when the cerotic acid dissolves, leaving the myricin, which is a true typical wax, being a palmitate of myricyl $\left.\begin{matrix} C_{16}H_{31} \\ C_{30}H_{61} \end{matrix}\right\} O_2$: it is finely crystalline.

Perhaps, if there be *cerolein*, it is that which, by its abundance or exactness, gives the characteristic qualities to all these different waxes. On this stand there are over forty varieties, from every country at all noted for that product, and yet an experienced eye and nose will pick you out and assign most of them to their native lands. Here we have bright yellow wax from Holstein and Denmark, the golden produce of Senegambia, the parti-coloured mixture from Australian hives, and the soft, dark ceral of Mogador. This gamboge-tinted specimen comes from Mexican woods; this is wasp-wax, soft and dirty

looking; this again, almost white, comes from Brazil. According to Mr. Hehner, whatever the physical properties and appearance of these multichroic specimens, their composition varies but little. Even that little he inclines to attribute to man and the advance of civilisation, rather than to any fault on the part of the bee. Of old, if the sable bee-owner had not sufficient tale of wax, he artlessly introduced a stone or lump of iron, or a bone or two, to make up the weight, or, at most, stirred in a quantity of coarse sand. But now every conceivable fat, cheap paraffin (imported for the purpose), palm oil dregs, &c., are employed as adulterants, not detected till the bleaching ground or candle, by defective performance, exposes the deception. There is no remedy. The agent who collects the tributary supplies from a hundred homesteads, mixes all the lots, and the hundred agents' deliveries are again thrown together. What help is there? But, by careful sampling, a keen buyer manages to escape with about 75 per cent. of pure wax. This comes to the factory as you see it, and, in its present form is useless. The first step is to "clear it down"—which is much the same as "rendering"—boiling with a little weak acid and water which separates all dross, and leaves the wax clean, though dark in colour. The next operation is that of bleaching. This may be done in two ways; by air, or chemical action. The latter can only be applied to wax that is not intended for candles; the grain becomes highly crystalline, and the burning power deteriorates. Why this is, I cannot say as yet; we must look to Mr. Hehner's researches for the future explanation. To whiten the wax chemically, it is treated with sulphuric acid and bichromate of potash, whereby ozone is liberated, and that discharges the colour. As the chromium salts impart a powerful green tint to the wax, it has to be boiled considerably with further libations of acid water, till, finally, it assumes this appearance. Observe how short and friable the grain here—you will see the crystalline structure upon closer inspection. If I were authorised to hazard an explanation, it would be, that in the gentle performance of atmospheric bleaching, the *cerolein* (presuming such to exist) only is destroyed; by the violent attack and heat of the chromic-acid, the myricin is split up into acids, palmitic and cerotic. In brief experiments, I have found that air-bleached wax dissolves in alcohol to pretty nearly the same extent as when crude, while the chemically whitened body is far more soluble than before, which, if correct, points to a great increase in the quantity of acid, and decrease in myricin. My assistant is now performing the operation of chemical decolourising. Observe the deep green colour, and great heat, sufficient, as you see, to boil alcohol. After the lecture, I will show you the small cake of wax, not entirely blanched, but much whiter than before.

To bleach bees-wax atmospherically, requires time and fair weather. The melted wax is allowed to trickle through a slit pipe over a drum revolving in water. This divides it into ribbons, which are rescued from the water by a rake, and spread on long canvas sheets—about forty feet by three feet. Here they sojourn during the fine summer days, being discreetly tossed and turned, and sprinkled judiciously with water, till the colour is discharged from the outer film. Again melted and divellated, it undergoes another exposure, and yet, perhaps, another, according to its nature, till of the yellowish white peculiar to itself. It is then run into cakes and stored for use. We may as well follow it to the end, and see how it is made into candles. A very favourite method in olden days was to apply the wax, made plastic in hot water, to the wick with the hand, by kneading and manipulation, reducing it to proper form. But this was a lengthy process, and the water was difficult to expel, producing spluttering. The candles were also dipped, like tallow-lights; but this method would only answer in short cases, and the generality of wax lights are passing long. Moulding, somehow, will not answer with wax; the candles refuse to leave the moulds, or crack while doing so. So now they are "poured." Round this wooden hoop you will notice a number of strings, to each of which, by means of a little wax, my assistant will join a wick. The hoop is now hung over a cauldron of melted wax, "and, be very careful, I pray you," says an old manualist, "of the temperature, lest, all too hot, the wax refuse to adhere to the wick; or too chill, hardens before the whole length be run." Dipping a ladleful from the cauldron, the operator revolves the hoop with one hand, while he pours the fluid material over the wicks with the other. After three or four revolutions, that hoop is laid aside, and another taken in hand. On this frame, the candle is arranged *in crescendo*, showing the increment gained after each pouring. At a certain period, the candles are reversed, as the tendency is naturally to thicken at the

lower extremity. Being now of tolerably even diameter, though unsightly, they are plucked from the strings, and laid in a row of about six upon a marble slab, sprinkled with water. The maker then proceeds to roll them under a board, upon which he throws all his weight, and by this, the still plastic substance is rendered of a smooth and even surface. With knife and gauge, the candles are cut to the required length, and their tops trimmed with a piece of wood. Hand labour, you see, throughout, and requiring much skill and experience. A well made wax candle should show rings like a tree, where the different layers have been superfused.

To make the little Christmas tapers and wax spills, a method called "drawing" is employed. Here the wick is wound off one drum on to another. In its passage it passes through a basin of melted wax, coloured with pigment, leaving which, it passes through a die, perforated with holes varying in diameter from $\frac{1}{60}$ to $\frac{1}{2}$ inch. The wick passes and repasses, till sufficiently thick. The large sizes are cut into tapers for Christmas trees, the thin wicks into lengths of about 8-12 inches, and are made up into bundles of assorted colours. To "feather" the ends, to facilitate lighting, they are dipped into hot water, and "flipped" over the arm, the melted wax flying off, and the ends dispersing.

Considering the expense of the raw material, also the skilful labour and time required for its manufacture, it is not surprising that wax candles should be dear, and highly prized. They have long been the currency for paying spiritual debts, and many tons of candles are devoted to this purpose. For carriage lamps, where a hard substance is required to resist the upward pressing spring, wax "moons" were long the only ones adopted, till ozokerit literally "took the shine" out of wax in light and hardness. Many quaint and obsolete customs were connected with the candle, as "selling by candle," when the bid was knocked down after a certain length had burnt; "excommunication by candle"—

"The priest called for candle, for bell, and for book,"

where the grace and time for penitence were adjudged by the same measure.

The introduction of cheaper substitutes has enabled many to reconcile piety and economy. Vegetable waxes are as taintless as bees-wax, and being some of them harder, last longer. Of these the name is legion, and we can only consider the most important; but, first, we must devote some little time to the beautiful rival of bees-wax, spermaceti, itself a true wax.

Spermaceti (*Wallrath*, Germ.; *Blanc de balaine*, Fr.) is written in old works *sperma ceti*, testifying to the belief then current that it was the spawn of the whale. The history of the rise of this industry is fraught with interest. Till nearly 1700, men's ideas concerning the nature of the substance were very vague. Sir Thomas Browne excuses his ignorance on the plea that "the learned Hoffmann says, "*nescio quid sit.*" In 1686, doubts were set at rest by the finding of a dead whale on the coast of Norfolk, from which unmistakeable spermaceti was taken. When this solid came to be employed in candle manufacture, for which it is so eminently adapted, I do not know. It seems for a long time to have been employed in pharmacy alone. Thomas Browne, for instance, lauds it as a "ground for compound oyls and balsams," and another old savant prescribes it in all cases "where acrimonious humours are to be obtunded;" and so in many others. It is still very largely blended in unguents, as I need not remind you; but, of course, now its chief use is for candles.

The black or Greenland whale fishery was carried on long before the haunts of the sperm or cachelot-whale had been discovered. The earliest mention made of the latter is by one Mr. Norwood (1667), who, talking of the Bermudas black whale fishery, "has heard from credible persons of another whale having great teeth—from which they got, as it lay dead on the beach, a quantity of *sperma ceti;*" and Mr. Stafford, several years after, speaks of the difficulty and danger of catching the sperm whale, "such as its fierceness and swiftness,"

But the matter was not allowed to drop there. America took to the chase so kindly that, between 1775 and 1779, she sent out nearly 500 ships to both north and south Atlantic Oceans, which brought in over 30,000 tons of oil. Mr. Burke remarked witheringly on the sloth of the English in this matter, as compared with the activity of their cousins. "No sea, but is vexed with their fisheries, no climate that is not witness of their toils." This appears to have taken effect, for, in 1776, the Government offered a large bounty to the largest cargo of sperm oil brought home under certain specified conditions. From this time forward the cachalot whale must have been surprised to find himself the recipient of such marked attentions. In the year 1786, above 326 tons of pure sperm oil were introduced

into England. The bounty was increased, and almost immediately afterwards the great step was taken of doubling Cape Horn, hitherto an unaccomplished feat, and carrying the war into the Pacific, the real home of the sperm whale. The captures now doubled and quadrupled. In 1819, Mr. Enderby, who had already received two bounties for two ships which had made voyages of most unprecedented good fortune, fitted out the *Syren*. This vessel chose the new hunting grounds of the Japan sea, and with such judgment that, after two years absence, she returned with the enormous cargo of 346 tons of sperm oil. The trade being now fairly started, the Government discontinued the bounty. But the impetus given received no check—the gain of sale was sufficient inducement; and the cargoes increased in number and tonnage, till 1831, when 7,065 tons came into British ports.

It is difficult for even a fertile imagination to overpaint the advantage which accrued to trade, science, and navigation, through the enthusiastic following up of this exciting fishery. We shall find a parallel, perhaps, in the palm oil trade, though of a different scope. When one considers the vast extent of water over which these leviathans roam at will, and the remote fastnesses to which they fly from their pursuer, also the enormous yield got from their carcases without other expenditure than the fire to "try down," and the barrels to hold the oil, it needs no dilating to show how universal benefit must result.

The details of the fishery are known to everyone. Not quite so well, perhaps, the difference between the three whales—the "right," the "sperm," and the "bottlenose." The following diagrams give the outlines of these quasi-fish, also that of the dolphin, or false bottlenose.* (Fig. 4, p. 840). There are, of course, innumerable species of this order of mammalia, ranging from the seal to the porpoise, all of which yield oil; but we can only give the most cursory consideration to the above-named three. The Greenland, or "right" whale (Fig. 1) *(Balæna grœnlandicus)*, also known as the "black whale," yields whale-oil, which, in many ways, differs from sperm oil. This balæna inhabits northern latitudes chiefly, but is found astray in many southern regions. He is toothless; his mouth is furnished with whalebone, and his head is rounded, the skull being of an entirely different form to that of the cachalot. His fat is also more readily saponified, and deposits little solid on cooling; the lighting and lubricating properties also

FIG. 1.



BALÆNA GRŒNLANDICUS.

are far inferior. The cachalot, or sperm whale (Fig. 2) (*physeter macrocephalus*), so called from its enormous head—nearly 14 feet high by 25 feet long—is a denizen of the south. His skull is long, depressed, and pointed; the dotted lines, in each case, show the position of the bones. The great bulk of the head consists

FIG. 2.



PHYSETER MACROCEPHALUS.

of a dense cellular tissue, infiltrated with spermaceti (*c*). This is called the *junk*, and is surmounted by the *case* (*b*), which holds nearly a ton of very fine oil and sperm. This is termed the *head matter*, and it is still asserted, in most books on the subject, that this is the only source of spermaceti. The error—for such it is—has arisen from the fact of the head matter being full of the sperm crystals when taken from the head; while the body oil does not deposit till after melting and cooling out. The *blubber* surrounds the whole body in a layer of about 18 inches thick. It is a fine fat, much resembling the fat of hot roast beef, and is hardly solid at ordinary temperatures. This is stripped off the whale, and packed into barrels, unless "tried down" on board ship. Trying down means simply melting, to clear down the fibre and skin from the oil. This soon deposits thick scales of sperm, and arrives at the factories in a semi-solid condition; in winter the barrels have to be steamed, to extract the contents. The mass then undergoes several filtrations and pressings. At first it is run into long bags of hair or canvas, and allowed to filter simply by its own weight; any pressure at that stage tending to force the only semi-solid sperm through the

* This is the species now on view in the Brighton Aquarium—a true dolphin.

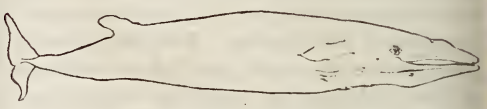
fibres. This process is called "bagging." When as much oil has filtered out as possible, the flaky mass is transferred from the long bags to square ones, which, placed between boards in layers, are subjected to pressure by superposed weights, gradually increasing till a certain limit. Hydraulic pressure is then applied, in the cold at first, afterwards with the aid of heat, the sperm having been melted and cast into moulds once or twice during the different pressings. Finally, the almost white wax is warmed and agitated with a little caustic potash, which removes the last traces of colour, and then is cast into blocks. Thus purified, spermaceti is an almost blue-white glistening semi-crystalline substance, melting at 113° F. Messrs. Bicknells, the well-known sperm finers, who kindly placed their factory at my disposal for the above information, have prepared this block of sperm for exhibiting the crystals. The interior has been run out while warm, leaving the splenddly serrated interior displayed. They are not true crystals—as far as I know, no distinct form has been isolated —but are, nevertheless, highly structural and characteristic. It is my belief that palmitate of cetyl itself would be crystalline, but that the inseparable constituents prevent this.

The constitution of sperm has received a good deal of attention, though, like all the fats, very difficult to ascertain exactly. It mainly consists, as I said, of cetyl palmitate $\left.\begin{matrix} C_{16}H_{31}\cdot \\ C_{16}H_{33}O \end{matrix}\right\}$ O· which, on distillation, yields a peculiar substance, called *ethal* (cetyl alcohol, $C_{16}H_{33}OH\cdot$) the alcohol of cetene $C_{16}H_{32}$. On long boiling with potash, sperm, like other waxes, forms a quasi-soap, but yields no glycerine, cetyl being liberated instead.

Owing to the pure condition to which it can be brought, and the uniformity of its constitution, sperm makes the finest candles we have, for regularity of flame. Having large wicks, to allow of quicker consumption of the easily melting wax, the flame of a sperm candle of ordinary size is greater than those of others. For these reasons, the spermaceti candle, burning 120 grains per hour, has been chosen as the standard measure of light over all the scientific world.

The "bottle nose" whale has been a subject of much doubt, and great, though surreptitious utility. The sketch (Fig. 3) shows the *Balæna rostrata* of Fabricius (Hunter, Phil. Trans., 1787), which is the true bottle nose whale. It is smaller than the balaena and cachalot, seldom exceeding 30 feet. Although, no doubt, thousands of these fish have been caught, and their oil sold as sperm oil, it is only quite recently that the oil has been made a distinct commercial article. Messrs. Bicknell have taken the matter in hand, and extracted, after much experiment, real spermaceti therefrom, of a slightly higher melting point than the cachalot sperm. Mr. Allen has published several communications concerning this oil, on which I may have more to say when we speak of oils proper.

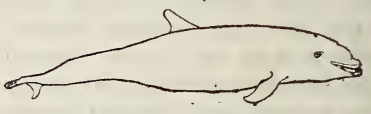
Fig. 3.



Balæna rostrata.

I will now pass on to those of the vegetable waxes which their importance entitles to a brief consideration. There are four that may fairly be deemed regular visitors of the British markets. The first, for beauty and purity, is *Chinese wax*, or *pela*.* This exquisite substance has a longitudinal crystalline fibre,

Fig. 4.



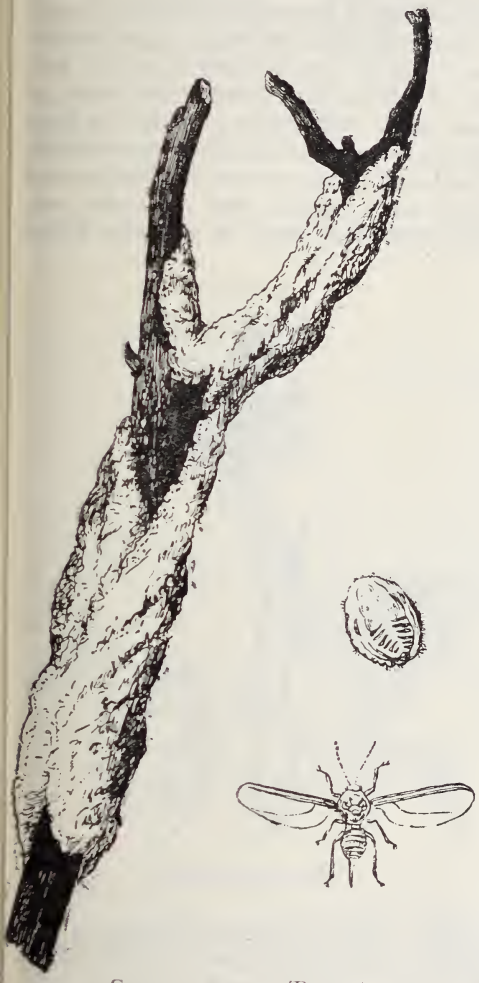
Delphis delphinus.

much resembling pure stearine, and yet with something of the flakiness of sperm about it. It is a cerotic *ether*, having the seldom varying composition $\left.\begin{matrix} C_{27}H_{53}O \\ C_{27}H_{55} \end{matrix}\right\}$ O, cerotate of ceryl, corresponding to the true cerotic ether $\left.\begin{matrix} C_{27}H_{53}O \\ C_2\,H_5 \end{matrix}\right\}$ O, or cerotate of ethyl. It melts at 180°F, and can be crystallised unchanged from boiling alcohol. The maker of this beautiful compound is a certain little insect, the *Coccus sinensis*, inhabiting China. The body of the grown insect varies in diameter from $\frac{1}{3}$-$\frac{2}{5}$ in. The diagram (Fig. 5) showing insect, grub, and twig of tree with a coating of wax, is taken from a sketch in Hanbury's "Science Papers," where there is also a very careful description of the insect itself. Its cultivation demands as much care as that

* Chinese, Chung-pih-la. Insect white wax.

of the silkworm. The cocoons with eggs are attached carefully to certain trees; after a short time the young insects emerge, and commence operations on the bark; this speedily becomes covered with a white waxy film, in which the insects imbed themselves; the branches are then scraped carefully of the adhering crust, which is readily purified, by boiling, from the dirt and insects.

FIG. 5.

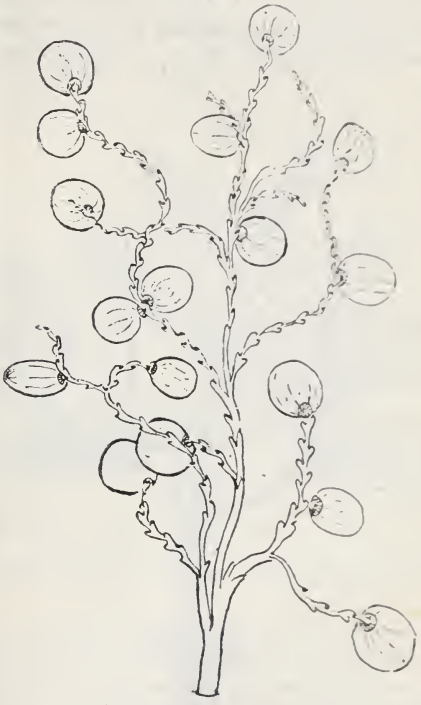


COCCUS SINENSIS (PIH-LA).

Some portions of the wax, with the incerated chrysales, are kept for breeding purposes. The trees on which this insect feeds are for the most part, probably all, themselves wax producers. Its favourite pasture appears to be the *Rhus succedanea*, from the root of which Japan wax is obtained. This circumstance renders it doubtful whether the insect could produce wax upon any tree, given proper climate. My opinion is, that the wax is the result of a mutual understanding between the two—a product to which insect and tree are equally essential factors.

The amount of this wax realized is very large, averaging about 200 tons. This the Chinese consume all themselves, the price not allowing it to compete with equally useful English products. A little comes over now and then, but the sales are never large. Its chief use is to "break the grain" of spermaceti, the two crystallisations neutralising each

FIG. 6.



COPERNICIA CERIFERA.

other; but as cheaper substances answer equally well, there cannot be much demand But the Chinese, who eat all the animal fat they can get, are very glad of the material for their candles. Their *lobchocks* are made from it; this one is, quite characteristically, thicker at the top than the base, tapering downwards, and coloured bright scarlet.

Carnauba, or stone-wax. — This peculiar wax is intensely hard, and its melting point very high—too high for utility, as regards candles at least (185° F.). It is, however, I believe, used largely on the Continent as an adulterant, or, perhaps legitimately, a hardening mixture, and enters largely into the

composition of varnishes, heel-balls, &c. The colour varies from light yellow to deep gray green, and it can be bleached to an intense white. Carnauba wax is found adhering as a thin film, like varnish, to the leaves, stalks, and the berries especially, of a Brazilian palm, the *Copernicia cerifera*. (Fig. 6). From these the wax is boiled off, and skimmed into moulds. When congealed, its likeness to stone is so great that, were it not for the low sp. gr. (999), one might easily class it with minerals. The composition of stone-wax is very uncertain. Lewy, a great authority on waxes, finds it to contain 80 per cent. of carbon; and Allen vouches for the presence of a notable quantity of free myricyl or melissic alcohol $C_{30}H_{61}\}O$. The quantity

FIG. 7.



MYRICA CERIFERA.

produced is very large, but I am not in possession of trustworthy statistics.

The next, and last, of the true waxes is *Myrtle wax* (Myrica tallow). This soft green substance is formed on the berries of the *Myrica cerifera*, an American tree shrub. (Fig. 7.) The berries grow in small clusters along the stem, and, when ripe, are covered with a tolerably thick rind of the wax, which is removed by boiling. This substance is also used chiefly in adulteration, though, from the very low melting point (123° F.), the use must be limited. The composition is chiefly palmitic and myristic acids, with a little glycerine, but has never been accurately determined. *Japan wax*, also called "tree wax," ought properly to rank as a fat, being a palmitate of glycerine, which latter it yields upon saponification. It is derived from the roots of several trees of genus *Rhus*, chiefly from the *Rhus succedanea* of the East Indies. (Fig. 8.) The use of this wax as an adulterant is checked by its disagreeable odour—otherwise, it is a very useful substance; it enters largely into the composition of vegetable wax candles, much used as a substitute for those of genuine beeswax. Its sp. gr. is about ·999, the m.p. 120° F. There are several other waxes, of great use in their native countries, as *palm wax*, from the stem of the *Ceroxylon andicola*, Brazil, and *ocuba wax*, from the *Myrica ocuba* of the same country; also Andaquies wax, Cuba wax, and others of uncertain animal

FIG. 8.



RHUS SUCCEDANEA.

origin. The two first-named furnish a large portion of the candle power of northern South America.

I shall have to defer to next lecture the consideration of vegetable oils and fats, which are also very numerous. For the present, I will conclude with drawing your attention to this unique collection of all kinds of waxes, with a number of different candles with crude wicks, made by island savages as they best knew, for the most part of which I am indebted to the courtesy of Mr. Holmes, of the Pharmaceutical Society's Museum.

CLASSIFICATION OF FATS.

MINERAL.	WAXES.	OILS.		GLYCERIDES.	
		ESSENTIAL.	FIXED.	VEGETAL.	ANIMAL.
Naphtha Petroleum Bitumen Ozokerit Paraffin	Spermaceti Beeswax Pela Myrtle wax Carnauba ,, Ocuba ,, Gen. form.	Turpentines (Lemon and Bergamot Group) $C_{10}H_{16}$ Camphors (Rosemary and Lavender) Gen. form.	Allen's Arrangement Olive Oil Group Cotton ,, ,, Linseed ,, ,, Castor ,, ,, Whale ,, ,, Lard ,, ,, Tallow { vegetal / animal Spermaceti	Japan wax* Palm oil Cocoanut oil Olive ,, Cottonseed ,, Linseed ,, Castor ,,	Tallow Lard .. Seal oil Whale ,, Fish ,, ..
$C_n H_{2n} + 2$ and $C_n H_{2n}$	$C_n H_{2n} + 1$ / $C_n H_{2n} \pm 1$ } O_2	$C_{10} H_{16}$ / O }			
	* Japan wax though physically resembling the true waxes, is a pure palmitate of glycerine; hence ranks with the glycerides.	Glycerin (triatomic glyceric alcohol). $C_3 H_5 (OH)_3$		Gen. form. *a.* $(C_n H_{2n-1} O_2)_n$ or *b.* $(C_n H_{2n-3} O_2)_n$ *c.* $(C_3 H_5 (OH)_3 - n$ *a.* Acetic (palmitic) series of acids. *b.* Acrylic (oleic) acids. *c.* Glycerin.	

The general formulæ given for the waxes and glycerides represent the composition of these, in some cases, highly complicated compounds, and mixtures of compounds, as accurately as can be hoped. Thus Chinese wax, pela, the best type of a pure wax, has the formula $\left.\begin{matrix} C_{27} H_{55} \\ C_{27} H_{53} \end{matrix}\right\} O_2$ cerylic cerotate. Stearin $(C_{18} H_{35} O_2)_3$ (tri) $C_3 H_5$ } 1 and Olein $(C_{18} H_{33} O_2)_3$ (tri) $C_3 H_5$ } In the latter cases, the whole of the hydroxyl in the glycerine has been replaced by the radicle.

Miscellaneous.

THE ANGERS HEMP INDUSTRY.

It is not precisely known from what period the cultivation of hemp in Anjon dates, but it is recorded that in 1748, the Joubert family established, by royal permission, a sail-cloth factory at Beaufort-on-Vallée, which was afterwards transferred to Angers, where it still exists. In 1752, the brothers Danton obtained the privilege of founding at Angers the manufacture of printed goods, but this industry seems to have failed to establish itself permanently in the district. There are (according to the *Moniteur des fils et tissus*) several important houses at Angers engaged in the hemp industry, whose products are favourably known in other countries.

Within the last thirty years wages have considerably increased in the Angers district, the augmentation being about 25 to 30 per cent. for spinners and other operatives engaged in the earlier stages of manufacture, while weavers are receiving double the wages they were getting in 1850. The introduction of power-looms has increased the quantity produced, thus allowing of an augmented remuneration to the workpeople engaged in this branch of manufacture. The general condition of the operatives is far more comfortable than was formerly the case. This result is due in a great measure to the encouragement given by the leading employers to the spread of economical habits amongst the working population. In one factory every workman who saves 100 francs during a year out of his wages, receives from the firm 15 francs as interest. This harmony of feeling between employer and employed allows of industrial changes being carried out when necessary, without the difficulties arising which are often met with where a less friendly tone prevails.

Notes on Books.

Hand-books issued in connection with the Great International Fisheries Exhibition, 1883.

THE FISHERY LAWS. By Frederick Pollock.

ZOOLOGY AND FOOD FISHES. By George Bond Howes.

HAND-BOOK OF THE MARINE AND FRESHWATER FISHES OF THE BRITISH ISLANDS. By W. Saville Kent.

These are first three of the series of Hand-books now being issued upon subjects cognate to the International Fisheries Exhibition. Mr. Pollock deals with the law relating both to Fresh-water and Sea Fisheries. Mr. Howes illustrates the zoology of fish by examples taken from some of the best known food fishes, and Mr. Saville Kent gives a descriptive summary of the entire fish fauna of the British Islands, which is also intended to serve as a reference catalogue to the series of spirit-preserved British marine and fresh-water fishes collected by Dr. Day. This collection, after exhibition in its present position, will be given to the nation, and placed permanently on view in the Buckland Fish Museum.

Papers of the Conferences held in connection with the Great International Fisheries Exhibition.

ON THE CULTURE OF THE SALMONIDÆ, AND THE ACCLIMATISATION OF FISH. By Sir James Ramsay Gibson Maitland, Bart.

It is proposed to publish all the papers read at the Conferences, with the discussions, and this paper on the *Salmonidæ* is the first issued.

Obituary.

MR. PETER SPENCE.—On Thursday, July 5th, died at his residence, Erlington-house, Old Trafford, Manchester, Mr. Peter Spence, the well-known manufacturing chemist, who had been a member of Society of Arts since 1862; and who, during that period, had taken much interest in the work of the Society. Mr. Spence was born at Brechin, in Scotland, and began his business life at Perth. Subsequently he took the control of some chemical works near Carlisle, and here, in 1845, by a patient course of experimenting, he discovered a process for the manufacture of alum from the refuse shale of collieries, and the waste ammoniacal liquor of gas-works, and this discovery was the foundation of his success. After patenting his process, he removed to Manchester, because the raw materials of his manufacture could then be readily obtained, and because the district supplied a good market for the finished article. A practical result of his invention was a considerable reduction in the price of alum. He continued through life to make experiments for the improvement of chemical processes, which caused him to take high rank as a practical chemist. Mr. Spence was in the 78th year of his age, and had been in failing health for some months.

General Notes.

CAGLIARI EXHIBITION.—The International Competion of Machines and Apparatus for Pumping Water to be held at Cagliari, Sardinia (see *ante*, p. 810), will be opened about the 15th of November, and information has been received from the Foreign-office, through the Science and Art Department, to the effect that the last day for sending in applications for admission to the competition is the 1st November next.

CHOLERA EPIDEMICS.—Mr. Edwin Chadwick, C.B., speaking at a late meeting of the Epidemiological Society, when a paper was read by Dr. J. M. Cunningham, the Sanitary Commissioner with the Government of India, on the sanitary lessons of Indian epidemics, stated that if the cholera did come, it would come as it came before. It would not appear in well-regulated prisons. It would not come in the district half-time schools, which were under the best sanitary regulations, including the personal cleanliness of the children, but it would visit severely filthy-skinned children, who are now subject to a fourfold death-rate, as compared with those district schools, from the ordinary epidemic diseases. It would pass lightly, if at all, over the common lodging-houses, the former chief seats of pestilences, but which were now freed from them by rudimentary sanitary measures under the superintendence of the police. It would, however, ravage severely the common ill-drained dwellings of the wage-classes, now subjected to double and threefold death-rates above those prevalent in model dwellings. The course of protection by quarantines, was condemned by the first General Board of Health as misleading and mischievous, and the latest experience now confirmed this condemnation, but the alarm of the visitation would be beneficial if it excited exertion for the removal of insanitary conditions of the pestilences which we have always with us, together with the detection and treatment of premonitory symptoms, which, under the first General Board, saved so much life in the last severe visitation. The medical officers present, in the course of the discussion which followed, though differing as to some methods of propagation and treatment, were unanimous as to the inutility and the mischief of quarantines, and as to the superiority of treatment by sanitation.

Journal of the Society of Arts.

No. 1,601. Vol. XXXII.

FRIDAY, JULY 27, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society

CONVERSAZIONE.

The Society's Conversazione was held at the International Fisheries Exhibition, South Kensington, by permission of the Executive Committee, on Wednesday evening, the 25th July. The reception was held near the entrance by Sir William Siemens, the Chairman of the Council, assisted by the following Vice-Presidents and members of the Council:—Lord Alfred S. Churchill, Lord Sudeley, Sir Philip Cunliffe-Owen, Sir Frederick Abel, Sir Edward Inglefield, Captain Douglas Galton, Sir John Hawkshaw, Sir Frederick Leighton, Sir John Lubbock, Sir Richard Temple, Mr. B. F. Cobb, Mr. W. H. Perkin, Mr. R. Rawlinson, Dr. Richardson, Mr. Carpmael, Mr. H. Doulton, Mr. T. V. Lister, Mr. J. M. Maclean, Mr. Matthey, Mr. Loftus Perkins, Mr. W. H. Preece, and Mr. Owen Roberts.

Their Royal Highnesses the Prince of Wales, President of the Society, and the Princess of Wales, accompanied by H.R.H. Prince Christian, and the Hereditary Princess of Saxe-Meiningen, and attended by Colonel Arthur Ellis, the Hon. Mrs. A. Hardinge, and Fraülein von Cohausen, arrived at half-past ten, and were escorted through the building by Sir William and Lady Siemens, Sir Philip Cunliffe-Owen, and the members of the Council, after which their Royal Highnesses proceeded to the Royal Pavilion.

The Exhibition Buildings, the Conservatory of the Royal Horticultural Society, &c., were lighted up by the electric light, and the gardens were illuminated throughout with coloured lamps, as well as four large Siemens electric lights, put up for the occasion.

The band of the Grenadier Guards, conducted by Mr. Dan Godfrey, performed in the gardens. The band of the Royal Artillery, conducted by Cav. L. Zavertal, the band of the 6th (Thuringian) Regiment of German Infantry (by kind permission of His Imperial Majesty the Emperor of Germany), and the Hungarian band, performed within the buildings.

A vocal and instrumental concert, consisting of glees, &c., was given by the Royal Criterion Handbell Ringers, under the direction of Mr. Harry Tipper, in the conservatory, from 9 to 11 p.m.

Refreshments were supplied at buffets arranged at various parts of the building.

The number of visitors attending the Conversazione was about 6,500.

Among those present were—The Duke of Sutherland, K.G.; the Marquis of Hamilton; the Earl and Countess of Aberdeen; the Earl and Countess Spencer; Lord Alfred S. Churchill; Lord Claude Hamilton; Lord Houghton; Lord Monson; Lord Sudeley; the Baroness Burdett-Coutts, and Mr. Bartlett Burdett-Coutts; the Lord Mayor; Lord Aberdare; Mary Marchioness of Ailesbury; Lord Bramwell, F.R.S.; Lord and Lady de Vesci; Marquis of Hamilton; Earl of Ilchester; Lord Lawrence; Earl of Morley; Marquis of Stafford; Lord Stanley of Alderley; Viscount Tarbat; Lord Clarence Paget, K.C.B.; Right Hon. J. G. Dodson, M.P.; Right Hon. Joseph Chamberlain, M.P.; Sir Charles Dilke, M.P.; Right Hon. G. J. Shaw Lefevre, M.P.; Sir Lyon Playfair, M.P.; Lord Justice Cotton; Raja Rampal Singh; their Excellencies the Chilian, the Danish, the Japanese, the Netherlands, the Persian, and the Siamese Ministers; Sir Frederick Abel, F.R.S.; Sir Thomas Brassey, M.P.; Sir John Coode; Sir Phillip Cunliffe-Owen, K.C.M.G.; Sir Frederick Evans, F.R.S.; Sir Charles Hutton Gregory; Sir John Hawkshaw, F.R.S.; Professor Huxley, P.R.S.; Admiral Sir Edward Inglefield, F.R.S.; Sir John Lubbock, Bart., M.P., F.R.S.; Admiral Sir Frederick Nicolson; Sir Lyon Playfair, M.P., F.R.S.; Sir Richard Temple, Bart., G.C.S.I.; Sir William Thomson, F.R.S.; Sir Joseph Whitworth, Bart.; Mr. E. Birkbeck, M.P.; Mr. Montague Guest, M.P.; Colonel Donnelly; Captain Abney, F.R.S.; Captain Douglas Galton, F.R.S.; Mr. Rawlinson; Mr. Lister; Dr. Carpenter, F.R.S.; Dr. Hopkinson, F.R.S.; Mr. Alex. Siemens; Mr. Brunlees; Capt. Oldekop; Fung Yee, Secretary of the Chinese Legation; Admiral Spratt; Mr.

Crookes, F.R.S.; Colonel Festing; Mr. James Forrest; Mr. E. A. Cowper; Dr. Pole, F.R.S.; Mr. Abernethy; Mr. E. Cunliffe-Owen; Mr. R. A. Thompson; Major Wyndham Malet; Mr. Hyde Clarke; Sir Douglas Forsyth, K.C.S.I.; Major-General Sir Lintorn Simmons; Sir Julius Vogel; Colonel Sir John Stokes; Sir Charles Clifford; Sir Edmund DuCane, K.C.B.; Sir Bartle Frere, G.C.B., F.R.S.; Sir Lewis Pelly, K.C.B.; Sir Henry Lefroy, F.R.S.; Sir James Anderson; Sir Francis Knowles, F.R.S.; Sir Gerald Fitz-Gerald; Sir John Ellis; Sir George Yule; Sir Allen Young; Sir Joseph Fayrer, F.R.S.; Sir Thomas Nelson; Dr. Warren de la Rue, F.R.S.; Sir Robert Torrens; Prof. Story-Maskelyne, M.P., F.R.S.; The O'Gorman Mahon, M.P.; Mr. Hastings, M.P.; Hon. Lyulph Stanley, M.P.; Mr. Leonard Courtney, M.P.; Mr. Thomasson, M.P.; Mr. R. H. Paget, M.P.; Mr. Bernhard Samuelson, M.P.; Admiral Mayne, C.B.; Mr. E. J. Poynter R.A.; Mr. J. E. Boehm, R.A.; Mr. Charles Hallé; Hon. Evelyn Ashley, M.P.; Mr. J. R. Holland, M.P.; Mr. Samuel Morley, M.P.; Mr. Seymour Haden; Mr. Vicat Cole, R.A.; Dr. Stainer; Sir Barrow Ellis; Hon. Sir Ashley Eden; Sir Henry Thuillier, F.R.S.; Sir George Richards, F.R.S.; Professor Ray Lankester, F.R.S.; Sir Joseph Hooker, F.R.S.; Admiral Sir Cooper Key, F.R.S; The Dean of Westminster; Sir Edward Hamley; Mr. Alma-Tadema, R.A.; Sir James Douglass; Mr. Horsley, R.A.; Sir Joseph Bazalgette; Sir James Caird, F.R.S.; Sir James Paget, F.R.S; Sir John Strachey; Sir Frederick Richards, F.R.S.; Sir John Dalrymple Hay, M.P., F.R.S.; Sir Erasmus Ommanney, C.B., F.R.S.; Sir George Campbell, M.P.; Sir Montague McMurdo; Sir Charles Hartley; Sir Julian Goldsmid; Sir F. Dillon Bell; Sir Henry Barkly, F.R.S.; Sir Henry Sumner Maine; Admiral Ryder; Prof. C. T. Newton, C.B.; Baron Julius de Reuter; Dr. Gunther, F.R.S.; Prof. W. H. Flower, F.R.S.; Prof. W. G. Adams, F.R.S.; the Secretary and other officers of the Society.

The Council feel assured that the members will recognise how greatly the Society is indebted to the Chairman, Sir William Siemens, for taking upon himself the heavy additional expense incurred for this year's Conversazione.

After the Conversazione, Sir William and Lady Siemens entaintained the members of the Council and a company of friends at supper.

CANTOR LECTURES.

SOLID AND LIQUID ILLUMINATING AGENTS.

By Leopold Field, F.C.S.

Lecture III.—Monday, February 12th, 1883.

Continuing the consideration of those bodies which can be converted into candles without alteration of their chemical nature, we will discuss palm and cocoanut oils; although, like tallow, in an unmanufactured condition, their application is very limited. The family of palms is exceedingly large; and of the number many varieties contribute to the domain of light. I have mentioned the wax palm, which perhaps remits, next to those two which we are now discussing, the largest subsidies to the candle pan; but all other vegetable sources scarcely furnish a tithe of the quantity which is yielded by the *Elais guineenis*, the oil palm, and the *Elais melanococcus*, the cocoanut tree. The former is distributed mainly through the West Coast of Africa, sometimes penetrating pretty far into the interior. Its chief habitat is along the banks of the Senegal and Gambia rivers, which are lined with the rude factories where the natives extract the oil. The fruit of this palm weighs about twenty pounds, and much resembles a large artichoke intersected with small golden plums. The dried specimen I exhibit can give you little idea of the beauty of this highly oleaginous fruit as it grows on the tree. The berries are separated from the husks, and by boiling in water, are divested of their unctuous integuments. The deep golden oil floats on the top, is skinned off, and put into casks, where it assumes a granular semi-solid condition. There are many varieties of this oil, of which I have about thirty in these glass bottles, varying from deep greyish brown to a lemon yellow. The best is that known as "Lagos" oil. Originally, before the discoveries of Chevreul and Wilson, palm oil, from its soft nature, was of little use, as by pressing it does not become harder; but a certain kind of candle, which was called the "decimal" candle, from the fact of ten going to the pound, was manufactured from the "bagged" palmitin, bleached partially by exposure to air. Messrs. Hempel and Blundell, in 1836, took out a patent for making candles from pressed fats alone. These, however, are little used. Cocoanut candles, or candles from pressed cocoanut, were made, but it cannot be said with any

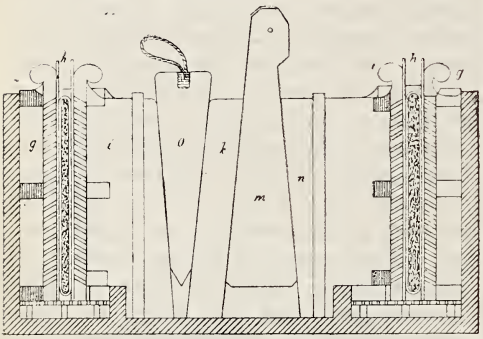
success. Whenever candles from the unmanufactured vegetable oils have been introduced, the glycerine present has proved almost as strong an objection in such cases as in tallow. In 1840, Mr. J. P. Wilson took out a patent for making the original "composite" candle, which was a mixture of the pressed cocoanut oil and stearic acid. These were the result of the demand for cheap self-snuffing candles which arose on the occasion of the Queen's marriage. It is a greasy candle, but comparatively cheap, giving a light of the intense whiteness characteristic of cocoanut oil. Cocoanut oil itself is obtained by pressing the dried and crushed ripe cocoanut. The best brands are sent from Ceylon and Cochin China. The nut is highly oleaginous, and is pressed when all the milk has solidified; a great portion of the oil is extracted, but a large quantity also is sent over in the dried kernel, called *copra*, to be crushed in English mills. It may be well here to mention night lights briefly, although we cannot give much attention to this little illuminator, of universal utility though it be. Night lights, at first called mortars (properly *mortuars*, being burnt by coffins and in dead chambers), are made chiefly of wax, blended with spermaceti, or pure. They have long been used, and their old form, as already observed, was the rush-light. The Romans used a night lamp and shade (*cubiculars*). With the introduction of cheaper materials than wax or spermaceti, their convenient form and elegant light could not fail to introduce a great demand, and by successive improvements in the composition and the cases; the substitution of stearine and pressed cocoanut in the former, and shaving or cardboard in the latter, the night light assumed an appearance to suit the most elegant, at a price within the reach of all. To Messrs. Wilson, of Price's Candle Company, these improvements are mainly due, though, I believe, it was Mr. Field who first encased stearine with cardboard. Messrs. Child's and Clarke's patents (1848-49-57), now adopted by Price's Company, are too well known to need any description, and refer to the special and improved manufacture of the night light and the apparatus for holding it. The amount of night lights consumed annually reaches 50,000,000. The manufacture is simple. The little cardboard case is supplied with a "sustainer," which is a small circular disc of tin with a hole in the centre to hold the wick which is attached to the bottom of the case by a spot of glue. The wicks being thus held upright, the cases are placed in a row and rapidly filled by hand from a kettle containing a mixture of cocoanut oil and palmitic acid; the composition, of course, varies with different makers. So much for the night light, although you would scarcely believe of how much time, labour, and numerous patents this little item has been the subject before it reached perfection.

Passing now to oils actual, and vegetal oils in particular—for I take the palm and cocoanut oils to hold an intermediate position between solid fats and liquid oils—we come to an immense class of seeds, used, some only in their native countries, and many universally, for producing illuminating oils. The chief oil of the old time was olive oil, which now, however, is rapidly being promoted to the rank of an edible, there being nothing special, either in its price or its light, to authorise its further supremacy. I have here several specimens of the olive, but this small dark berry, the *Olea Europæa*, is the olive of Italy and the East: the fruit of those silver-grey forests so familiar to all who have travelled along the Riviera and Palestine. The finest oil—what is called virgin oil—is obtained from the berries by gentle crushing; the inferior qualities are the result of harder pressure and ultimate boiling. But little olive oil is now obtained pure, and that which is, almost entirely devoted to culinary purposes. It is noteworthy that the Italian mill owners themselves find it cheaper to burn petroleum in their lamps, than their own produce. After the invention of Argand, colza oil, from the seeds of the *Brassica Europæa*, was very largely employed, as giving a brilliant light at a small cost, and this vied with sperm oil for a long time; but as olive is now adulterated with colza, so colza, in its turn, was adulterated with rape, and all of them find rivals in continental countries in ground nut, sesame, poppy, and other oils, all of which have characteristics more or less desirable. I have appended a list of the various oils obtained from seeds in all parts of the world, giving, where necessary, such details as may be interesting. But we must regard all these as things of the past, or passing, their places being now taken by petroleum and paraffin.* Although, till the latter are rendered equally inert, we cannot expect that the virtually safe vegetable oils will ever practically become extinct as illuminants, while their value to the soapmaker increases yearly. It would not be

* See note on page 851.

right were I, at this point, to make no mention of cotton seed oil, which year by year assumes a greater position in the oil dominion. It is capable of such a state of perfection that, both in appearance and other properties, under cunning treatment, it can, and no doubt does, pass for olive oil. The gigantic amount of seed thrown off in cotton harvests, and the high percentage of oil contained, renders competition on the part of any other seed abortive. Last year, there were 3,000,000 tons of cotton seed produced, of which only 300,000 tons were worked up, meaning 90,000,000 gallons of oil lost. If I describe briefly the manipulation of cotton seed to extract the oil therefrom, it will serve as a type of the processes applied to most other seeds. This diagram (Fig. 1)

Fig. 1.



Old Wooden Seed Crusher.

hh the seed bags enclosed in perforated boards—*i k n*, counter wedges of wood. The wedge *m* is drawn up forcibly, thus tightening the whole arrangement, and the wedge *o* is forced in by a heavy wooden block falling upon it.

represents an old seed crusher; the grains were subjected, in bags, to the pressure of wedges, on which "monkeys" fell, as in pile-driving. The advantage of such apparatus is its ready manufacture, the only essentials being timber and carpenters' tools. But now more perfect means are adopted, and the following description, which I owe to the kindness of Mr. Felton, secretary of the Cotton Oil and Stearine Company, applies to such.

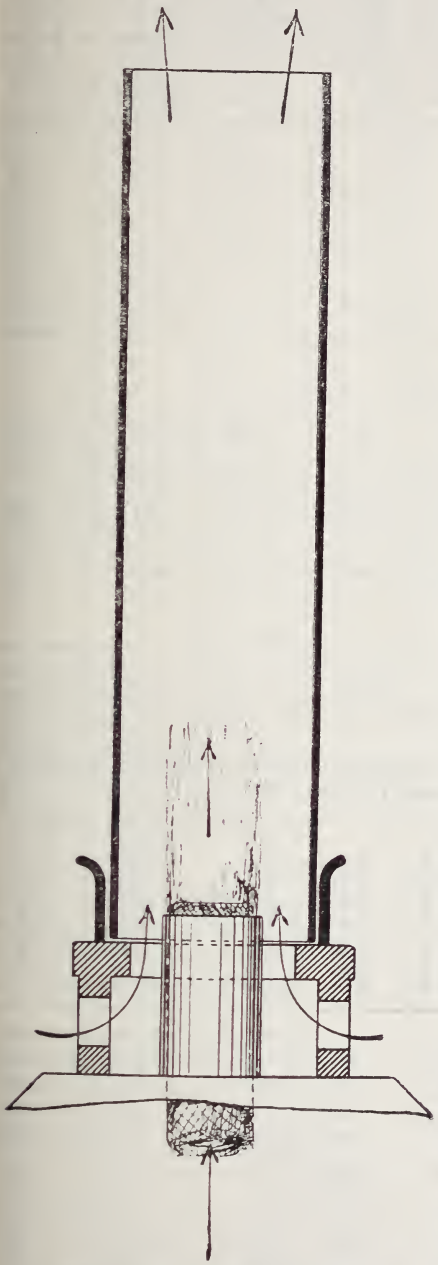
The seed is first crushed between iron rollers, and is then put under edge-runners (stones), which converts it into a rough meal. It is then heated in a steam jacketted pan, and, when sufficiently warm, is filled into woollen bags, which are put into hydraulic presses, horizontally, and pressed until all the oil is exuded, leaving the cotton cake perfectly hard. The oil, which is quite dark in colour, is then put into a tank, heated with dry steam to about 80° to 85° F., and treated with caustic leys sufficiently to throw down the residuum, consisting of fibrous and gummy matter; the oil, which is of a pale yellow colour, is then drawn off into another tank, and boiled in water, in order to thoroughly cleanse it from all impurities; after this it is filtered, and is then ready for sale. (It is not suitable for distilling). The residuum or foots is boiled up with open steam, and treated with acid, which, combining with the alkali, leaves a thick black grease. This, when distilled, yields a white stearine, also a hard black pitch.

Passing now from the oils themselves to the vehicles for exhibiting their burning powers, I solicit your attention to the magnificent lamps, which the kindness of the great manufacturers and others have enabled me to place before you. Perhaps no link of importance, from the old bronze lamp of Herculaneum, to the exquisite combination of high art and supreme light lent me by Messrs. Williams and Bach, in their Ibis lamp, is omitted. I will, however, not dilate upon beauty or quaintness of form, but content myself with expounding the principles of such as appear to me to constitute an essential link or step forward. The first invention of note must be considered that of Ami Argand, who, in July, 1784, took out a patent, which rendered the lamp practicable as a domestic luminant, and his name indissolubly connected therewith. The principal object of this lamp, to quote his own words, is "to give neither 'smoak' nor smell, and to give considerably more light than any lamp hitherto known." His first structure had simply a chimney* of iron suspended over the flame, which was afterwards exchanged for one of glass. The wick was circular and hollow, thereby admitting of a current of air on both sides the flame. The uprush of heated products of combustion from the top of the chimney, induces an equal ingress of fresh air from below (Fig. 2). By discreet adjustment of size and position of the chimney and wick, the supply of air is regulated to exactly impinge on the portion of the flame where the heated vapours come into contact with the atmosphere, and consumes the excessive carbon, which would otherwise appear as smoke. This invention underwent numerous modifications, at the hands both of the originator and others, but the principle remained unaltered. Argand's lamp, after successive improve-

* The chimney had, however, been suggested previously by Quinquet.

ments, consisted of the following parts:—An annular tube, on which the wick was stretched; a reservoir which contained the oil; a pipe leading from the reservoir to the wick, and a holder for the glass, which imparted, on turning, a spiral motion to the wick, and thereby adjusted the flame. The reservoir was of the kind known as the "bird fountain," whereby a bubble of air entering the small orifice at the base allows the egress of a small quantity of oil. This was first put into practice by Miles, in 1781; and has since been applied to

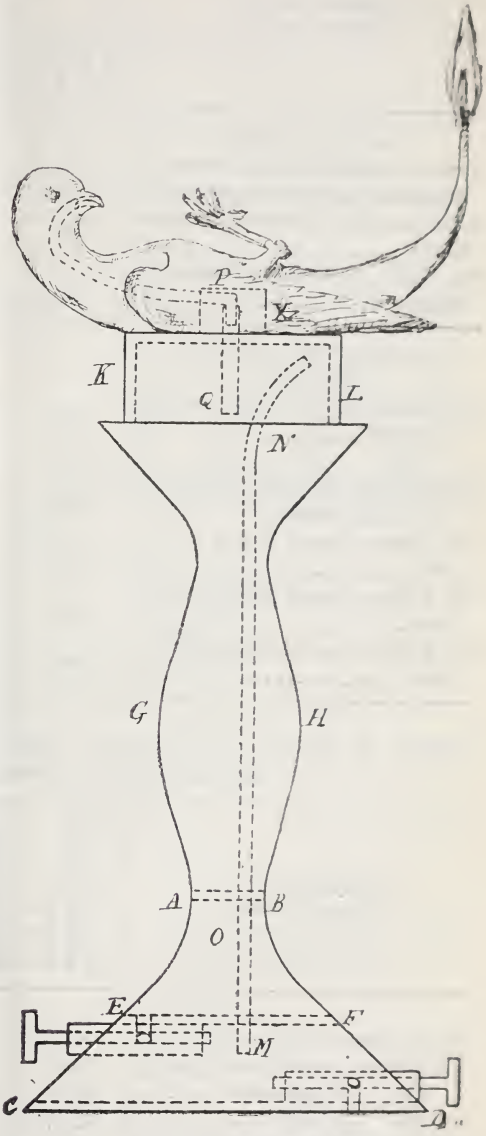
FIG. 2.



PRINCIPLE OF ARGAND BURNER.

The arrows show direction of air currents.

Fig. 3.



HERO'S BIRD LAMP.

a b e f, reservoir of salt water, which flowing into the air-tight chamber *c d e f*, through the tap *e*, forces the air up the tube *m*, into the oil reservoir *k l*. The air again, pressing upon the oil in *k l*, it is forced up tube *g*, into the beak of the bird, whence it drops into the reservoir *f*, and hence is drawn off by the wick to burn at the tail.

TABLE I.—Showing Illuminating Power of Original Argand Burners Consuming Colza and Petroleum Oils.

Description of Lamp. (Argand Burners.)	Illuminating power expressed in sperm candles.	Illuminating power expressed in cubic feet of common coal gas = 15 candles.	Hourly consumption of oil in grains.	Cost of oil for one week's consumption of 42 hours.	Cost of gas at 3s. 9d. per 1000 cubic feet for one week's consumption of 42 hours.	Proportional cost of gas and oil.
Colza Oil Lights.				s. d.	d.	
Lamp 1, consuming colza oil from an Argand burner, wick $\frac{7}{8}$ to $\frac{15}{16}$ of an in.	11·81	..	1,203	2 $9\frac{1}{5}$	..	..
Lamp 2, with imperfect chimney, wick $1\frac{1}{4}$	3·38	..	532	1 $2\frac{23}{35}$	..	..
Do. with differently constructed chimney	15·01	5	1,775	4 1	9·45	1 : 5·2
Petroleum Oil Lights, as originally constructed.						
No. 1 Burner, size of wick $\frac{7}{8}$ to $\frac{15}{16}$ of an inch	15·67	5·22	864	0 11·8	9·86	1 : 1·21
Do. do. do. ..	15·47	5·15	787	0 10·7	9·73	1 : 1·11
No. 2 Burner, size of wick same (of French construction)	14·93	4·98	818	0 11·1	9·4	1 : 1·18
No. 3 Burner, size of wick $1\frac{1}{4}$ of an inch	17·01	5·67	818	0 11·1	10·7	1 : 1·04
No. 4 Burner, size of wick $1\frac{1}{2}$ of an inch	33·85	..	2,145	2 5	..	..
No. 5 Burner, size of wick $1\frac{3}{4}$ of an inch	38·32	..	3,433	3 $10\frac{29}{35}$	..	..

TABLE II.—Showing Illuminating Power of Altered Argand Burners, Consuming Petroleum Oil, as Compared with Original Burners.

Description of Lamp. (Argand Burners.)	Illuminating power expressed in sperm candles.	Illuminating power expressed in cubic feet of common coal gas = 15 candles.	Hourly consumption of oil in grains.	Cost of oil for one week's consumption of 42 hours.	Cost of gas at 3s. 9d. per 1000 cubic feet for one week's consumption of 42 hours.	Proportional cost of gas and oil.
				s. d.	s. d.	
No. 1A Burner, wick	14	4·66	602	0 8·18	0 8·8	1 : 0·93
No. 1 Burner (original), wick $\frac{7}{8}$ to $\frac{15}{16}$..	15·67	5·22	864	0 11·8	0 9·86	1 : 1·21
Do. 2nd experiment	15·47	5·15	787	0 10·7	0 9·73	1 : 1·11
Do. (altered)	23·24	7·74	795	0 10·8	1 2·63	1 : 0·738*
No. 2 Burner (original), same size as No. 1 (of French construction) ..	14·93	4·98	818	0 11·1	0 9·4	1 : 1·18
Do. (altered)	21·52	7·17	788	0 10·7	1 1·55	1 : 0·79†
No. 3 Burner (original), wick $1\frac{1}{4}$	17·01	5·67	818	0 11·1	0 10·7	1 : 1·04
Do. (altered)	28·0	9·33	1,102	1 3	1 5·6	1 : ·85
No. 4 Burner (original), wick $1\frac{1}{2}$	33·85	..	2,145	..	..	..
Do. (altered)	46·5	..	2,008	..	..	..
No. 5 Burner (original), wick $1\frac{3}{4}$	38·32	..	3,433	..	..	..
Do. (altered)	50	..	1,965	..	..	..

* 35 per cent. cheaper than gas. † 27 per cent. cheaper than gas.

TABLE III.—Illuminating Value of the Principal Organic Oils.

Oil.	Duration of combustion under equal conditions.	Mean intensity of combustion, 40 gm. 8 h., in single wick lamp.
		Standard burner.
Colza, fine	29	1·04
,, trade	11	0·39
Ground nut.....	35	1·05
Olive	23	1·07
Sperm	29	1·05
Rape	23	0·82
Linseed	14	0·87
Whale	18	0·86
Gingelly	26	0·73
Cocoanut	41	1·06

The best oils for burning, arranged in order according to the above, would be cocoanut, colza, ground nut, olive, sperm, whale.

Note.—It is worthy of remark here that, according to recent experiments of Sir J. Douglas, with lamps brought to their present perfection, colza oil, contrary to what would be expected, gives a superior light to that of the best mineral oil. The cost, of course, cannot be taken into account, paraffin oil costing 9d. per gallon against 2s. 9d., the average price of colza. But the following table will give a good idea of the relative lights during 16 hours' trial in Trinity House:—

	Argand Burners. Colza.	Paraffin.
Maximum intensity of light produced	100·0	85·5
Minimum intensity at end of time (16 hours).....	81·8	66·9
Per-centage of falling off	18·2	21·9
Consumption of oil per lamp in fluid ounces for 16 hours	42·1	34·0
Relative quantity of light produced per gallon of oil consumed	100·0	103·0

Illuminating Power in Sperm Candles.*

	6 wicks.	4 wicks.	2 wicks.	Argand.
Colza oil..	722 cand.	328 cand.	82 cand.	23 cand.
Paraffin oil	730 ,,	330 ,,	80 ,,	25 ,,

Equivalent of Sperm to 1 Gallon of Oil.

	6 wicks.	4 wicks.	2 wicks.	Argand.
Colza oil..	26·76 lbs.	28·10 lbs.	25·77 lbs.	28·00 lbs.
Paraffin oil	24·98 ,,	26·94 ,,	27·43 ,,	28·57 ,,

Note.—A comparative table of the cost of light in various lamps and candles will be given at end of Lecture 6.

List of the Principal Oils Employed for Illuminating Purposes.

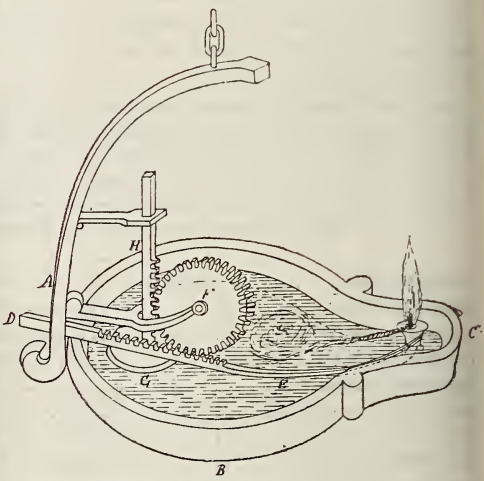
		Oil.	Acid.
Olea Europæa	Europe	Olive	Oleic
Linum perenne	,, ...	Linseed	(Lin)oleic
Papaver somniferum	,, ...	Poppy	(?) ,,
Cannabis sativa.....	,, ...	Hemp	,,
Sesamum orientale	,, ...	Gingelly	(?)
Amygdalus communis	,, ...	Almond	,,
Guilandina mohringa.....	,, ...	Behen	Benic
Helianthus perennis.....	,, ...	Sunflower seed	,,
Brassica campestris	,, ...	Rape	Erucic
Ricinus communis	Italy, India.....	Castor	Ricinoleic
Nicotiana tabacum	Europe, America	Tobacco seed	(?)
Theobroma cacao	South America	Cacao butter	Theobromic
Cocus nucifera	Ceylon, Cochin	Cocoanut	Rutic, caproic, caprylic, lauric, myristic, palmistic, &c.
Elais melanococcus	West Africa	Palm kernel	Rutic, caproic, caprylic, lauric, myristic, palmistic, &c.
		Palm oil	Palmitic
Arachis hypogæa	Tropics	Ground nut.....	Hypogeic
Gossypium Barbaderse	America	Cotton seed	Linoleic
Brassica oleifera	Europe	Colza	Erucic
Aleurites triloba	Polynesia	Candle nut	(?)
Attalea cohune	Honduras	Cohune nut	(?)
Bassia butyracea	East India	Vegetable butter	Stearic, palmitic, myristic
Colophyllon calabar.....	Central America	Calabar	(?)
Garcinia indica	India	Kokum	Palmitic, myristic
Rhus succedaneum	Japan	Japan wax	Palmitic
Stillingia sebifera.....	India	Vegetable butter	Myristic
Bassia parkii.....	West Africa	Shea butter	Oleic, stearic
Myrica sebifera.....	North America	Myrtle wax.....	Cerotic
Ceroxylon andicola	Brazil	Palm wax	,,
Copernicia cerifera	,, ...	Carnauba wax	,,

Sp. gr. varying from ·89 to ·92. Average yield about 55 per cent., though some, as the *Aleurites trilebo*, yield nearly 85 per cent., and others, as *Linum perenne*, only average 20 per cent.

a very numerous class of lamps, especially those known as "reading lamps," where the reservoir is higher than the wick. Argand's lamp was suitable for both colza and sperm oils. As the shape was ungainly, many expedients were devised whereby the flame could be fed from a reservoir below. Carcel, in 1798, brought out a lamp which was almost universally used for many years in France. The principle of this was pumping, by two little clockwork pumps, a supply of combustible to the wick. The only objection to this is the constant need of repair to which the delicate mechanism is liable. The supply, when in good order, however, was so extremely steady as to cause this lamp to be taken on the Continent as a standard of illumination. The problem of securing an unvarying supply of oil without such complicated mechanism was one which taxed the ingenuity of many makers. A very favourite means was that of hydrostatic power, whereby a heavier liquid solution was made to raise the lighter oil equably, as it consumed. This idea was evolved from the fertile brain of Hero of Alexandria, 200 B.C. In Fig. 3, a device is shown for solving the paradox of causing a liquid to rise above its own level, by the flow of a heavy salt solution, into an air-tight chamber, the air being driven into the oil reservoirs above, and forcing out the oil into the lamp. Fig. 4 represents another ingenious "idea," for trimming the wick by the descent of the oil; which I do not think, though, would be found to work. Barton, in 1809, invented a very elaborate combination of tubes and chambers, carrying out Hero's idea on an extensive scale, and in connection with an Argand lamp. This appears to have had a considerable popularity, but is now extinct.

Keir, in 1787, made a very ingenious lamp, consisting of two cylinders, the smaller floating in the larger. The wick was attached to the apex of the interior cylinder which contained the oil, and was open at the base, the exterior being filled with salt water. As the oil diminished, the salt water rose in the interior, and sank in the exterior reservoir, while the height of the interior cylinder was adjusted by means of a wooden float. Porter, in 1804, invented a lamp which deserves mention, and of which I have a diagram (Fig. 5, p. 853). It consisted of a rectangular box, balanced eccentrically, so that the position—horizontal at the commencement—during burning, gradually approached the vertical. A larger amount of oil being removed from the posterior, caused this to lose weight more rapidly than the anterior, the oil in which was thereby maintained at a level. The name of Smethurst is closely associated with lamps. He was the first to give a slope to the chimney, which Argand had left straight, thus directing the air-current more accurately, and thereby increasing the draught and the brilliancy of the flame. The next invention of importance took place in 1836, when Fanchot invented the moderator lamp as at present used. This had already been foreshadowed in the inventions of Stokes, 1787, Allcock in 1807, and Fayre in 1825, all of whom used pistons which forced the oil up under pressure. Fanchot gave the lamp its present form, which is, briefly, as follows:—The piston fits tightly in

Fig. 4.



Hero's Self-trimming Lamp.

By the descent of *c*, the rack *h* turning the cog-wheel *f*, pushes *d* forward, which is attached to the wick, raising it as the oil falls.

the reservoir, being provided with a leather collar, which admits of being raised with ease while the reservoir is full, but the descent is impeded by the collar being pressed against the sides by the liquid. There is, therefore, no outlet for the oil but by a fine tube passing through the piston up to the wick, which is, by this means, fed by a constant stream of oil, the surplus dropping down into the reservoir above the piston. When the piston has fully descended, it is re-elevated by a cog and ratchet apparatus. The flow of liquid up the tube is regulated by a fine piece of wire, which partly closes the same and helps to cleanse it. By these means, very heavy oils can be burnt, and perhaps no lamp has enjoyed greater popularity than this. Its

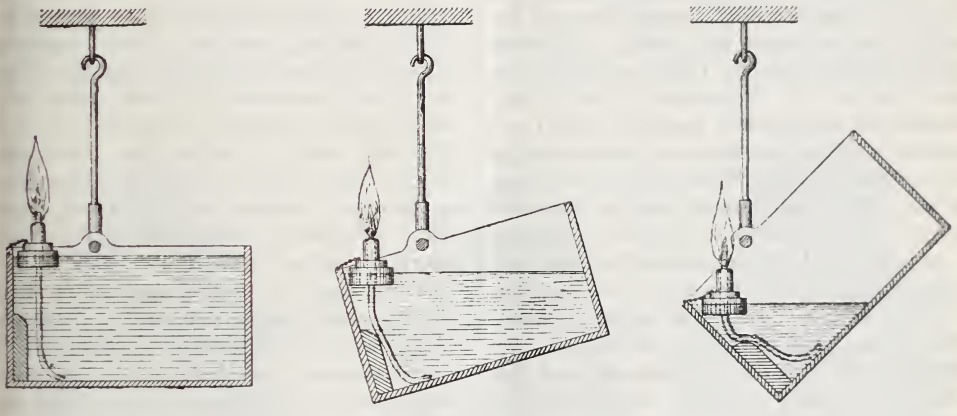
defects are the constant need of winding up, and liability of the fine tube to become clogged. Such are the chief historical forms of the lamp. I will briefly allude to Young's "Vesta" lamp, first used in 1834, which burnt "camphine," or turpentine, with a very brilliant snow-white flame; and the "Diacon" lamp, which was a modification of the moderator, invented and used in America. This lamp was made the subject of a characteristic novel, published in 1849, wherein a lady searches the world for the best kind of lamp.

The wick has been the subject of numerous modifications. As early as 1773, we find one Leger producing a flat-ribbon wick. Though a great improvement on that of the older cord wick, the flame was too thin, being blown out with every puff of air. Argand introduced the circular wick, which has maintained its form. A great step was made when the flat wick was forced, as in modern lamps, to adjust itself exactly to an annular tube, thus obviating the necessity of pushing the tube into an ill-fitting wick.

In 1865, Messrs. Hincks, of Birmingham, brought out a lamp with the parallel flat flames, called the Duplex, which gives a remarkably good light, and has a world-wide reputation. To the same firm, I believe, are due these ingenious devices for extinguishing and relighting the flame without moving the shade, by merely pressing a trigger.

I ought now to mention, as an entirely different variety, Mr. Holliday's vapour burner lamp, of which the specimen I have here is one of the many thousands to be

FIG. 5.



PORTER'S AUTOMATIC LAMP.

seen burning on the costermongers' stalls in East and South London. The conical reservoir at the top is filled with light hydro-carbon oil, passing through a tap and tube into a burner of peculiar construction, and being ignited by holding in a flame for a few seconds, will continue to burn without wick furiously and safely as long as the supply is properly regulated. This may be said to be the first lamp which burnt hydro-carbon oils, and no doubt for an open-air flame no better can be, or at any rate has been, devised. About this time invention was very active to devise means of burning hydro-carbon oils with safety, which were being used with more and more frequency in household lamps. In 1866, Leichenstadt invented a lamp for burning a mixture of benzole and camphor, but the dangerous nature of benzole rendered this form undesirable. Aaronson, 1875, by a clever combination of oil and water, constructed a lamp to be extinguished directly it was overturned, or even deflected from the vertical. This masterpiece could also be trimmed, filled, and lighted without moving the shade and chimney. Young and Silber are two names most prominent in the lamp problem. Mr. James Young, as the discoverer and first manufacturer of paraffin oil from shale, was naturally the appropriate inventor of means for its safe combustion, and Young's Company now still supply "Vesta" lamps for burning their own productions.

All the inventions thus briefly epitomised, have one or other of the following objects in view:—To supply oil regularly to the wick; to

apportion the supply of air to the description and quantity of oil to be burnt; to provide simple means for regulating the height of the wick, and consequently, the flame; and finally, to place the burning portion of the lamp in such a position as not to be obscured by the reservoir and other portions. The oldest lamps, as the antique Etruscan, and the cruisie of Scotland, were on the suction principle, and the wick depended for its supply upon its own capillary action. As the level of the oil was constantly varying, so the light varied also, and the first attempts of inventors were directed to maintaining an equal level of oil. The bird-fountain and hydrostatic reservoirs partly attained this end, and the Carcel and Moderator systems were perfect of their class, mechanical or pressure lamps. It is evident that suction lamps depend for their efficacy upon the gravity of the combustible. A spirit lamp, with a good wick, will burn very well, though the wick be several inches above the liquid. Elizabeth Leichtenstadt's patents, 1866, are directed to the burning of camphorated spirit and benzole, in sponge-filled reservoirs; but I am unable to procure specimens or information as to their performance. With liquids volatilising at such low temperatures, there is always a danger of the formation of explosive mixtures.

In 1834, J. I. Beale patented a lamp for "the burning of substances not usually burned in such vessels," under which he includes mineral and wood naphthas, and oils from the distillation of coal tar, vegetable tar, and the like; the principle being the vaporisation by means of a small secondary flame, from a separate source, which soon burns out, having started the vaporisation. This lamp had no wick; the supply of fluid was regulated by forced air.

Parker's lamp, patented 1840, should also be mentioned, as the most successful attempt at heating the oil before combustion. Here the upper part of the chimney was made of copper, and passed through the reservoir filled with a heavy luminant (preferably cocoanut or tallow). The air being extended, the oil fed the wick by it own expansion, regulated by an ingenious mechanism. This was a so-called "sinumbral" lamp, and appears to have been held, by some, superior even to Carcel's as a standard for photometry.

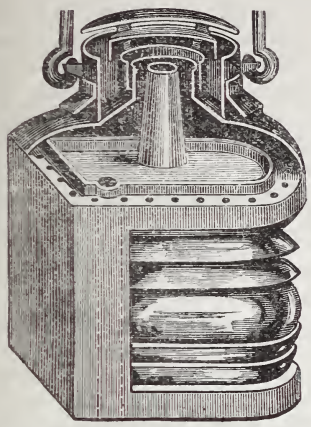
The supply of oil to the wick in all pressure lamps was in excess of the demand, and the surplus fell back into the reservoir. This can only be feasible in the case of heavy oils, especially animal and vegetal. The Russians boast of having constructed a lamp to solve the problem of burning their own heavy hydrocarbon oils, of which Baku produces so vast a quantity; but as the demerits of such oils, especially the clogging of the wick, cannot be ascertained in the few hours their committee appear to have spent upon the investigation, we must defer our meed of applause. The light hydrocarbons, such as petroleum, photogen, solar oil, and their polynomial varieties, must reach the arena of combustion in as small quantities, and at as high a temperature as possible, while the supply of air, both from inside and out, can scarcely be too abundant.

It must be remembered that this lecture has oils rather than lamps for its subject; and, therefore, we must be content with inquiring into the principles underlying the construction of the latter, leaving the mechanical beauties in which these apparatus abound for a more befitting occasion. Since compiling this lecture, also, I have found that Mr. Silber has already embraced its chief points in a masterly paper, read before this Society in 1870 (December 21st); in which also, the experiments of Mr. Valentine upon the Silber lamp are adduced. Under the circumstances, therefore, I will content myself with giving a brief description of the Silber lamp.

At first sight the burner appears to be a simple aggregation of concentric tubes—and this, in fact, it is. The use of these, especially of the innermost, bell-mouthed pipes, becomes very apparent in the lighted lamp. From the right hand one of these two lamps, both burning petroleum, with equal wicks and similar chimnies, I remove the interior tube—immediately the flame lengthens and darkens, wavers and smokes. The current of air which is, by this internal conduit, directed into the interior flame surface, is the essential principle of Mr. Silber's invention. The wick is contained in this metal case, surrounded by an air-jacket, which passes down the entire length of the lamp, leaving a small aperture at the base, through which the oil flows from the outer reservoir to the wick chamber. Thus, by the interposition of an atmospheric medium, the bulk of the oil is maintained throughout at a low temperature. Two concentric bell-mouthed tubes pass down the interior of the wick case, and communicate with the air at the base of the lamp, which, you see, is perforated for the purpose. Two cones, perforated, the inner and smaller, throughout, the largest only at

the base, surround the wick, and heat the air in its passage through the holes to the flame. The effect of these appliances is,

FIG. 6.



firstly, by the insulation of the outer reservoir, to avoid all danger of vaporisation of the oil, till actually in contact with the wick. As it is drawn nearer and nearer the seat of combustion, the hot metal wick-holder heats, and ultimately vaporises the luminant, so that at the opening of the wick tube concentrically with the air conduits—all of which are exceedingly hot—a perfect mixture of vapour and hot air is formed, and this it is that is burnt. An all important feature is the shape and position of the chimney which, Mr. Silber asserts, influences the flame to the extent of quadrupling its brilliancy if properly adjusted. The numerical results obtained by the photometry of these lamps, as to brilliancy and price, are truly gratifying. I refrain from quoting disjointed values, and beg to refer you to two tables given in Mr. Silber's paper.

I cannot enter into all the beautiful applications of this principle, with which the Silber Light Company have so kindly and bountifully supplied me. But upon this marine lamp, as it involves certain important modifications, a few moments may be spent with advantage. Its purpose is to maintain an even and steady light, during a violent tempest, with, it may be,

FIG. 7.

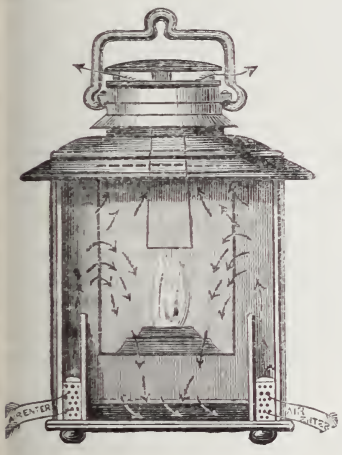


FIG. 8.

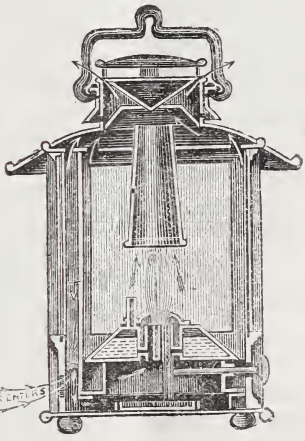
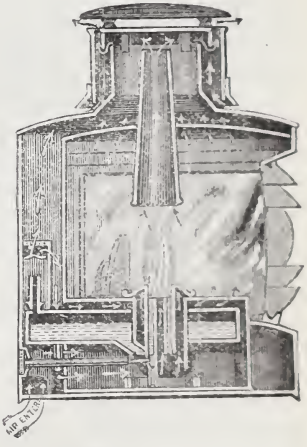


FIG. 9.



waves dashing over it. Fig. 6 shows you this lamp, with the top dissected. It is provided with a cut dioptric lens, and a powerful reflector, and the light, which is equal to that of fifty candles, can be seen, on a clear night, for more than five miles. Fig. 7 shows the interior of the lamp, in a glass model made for the purpose. The air enters a chamber, by means of two tubes, about one-third of the height of the chamber itself, perforated. This checks and dissipates the most violent current. After entering, the air expands with the heat, loses much of its velocity, and, being still cooler than the air inside, above the flame, descends to the chamber below the burner (Figs. 8, 9). As the heated products ascend, the fresh air is drawn up to the flame to supply their place. The smoke from this paper will best show the direction of the currents. You observe the rapidity with which the smoke rushes into the air-pipe, and enters the chamber, which velocity gradually diminishes in ascending, till it falls over, and descends to the lower chamber, whence it is drawn up and consumed in the flame. I direct a stream of air

from this powerful bellows against the inlet, and the flame you see as steady as ever. The products of combustion pass up a conical chimney, and strikes against the apex of an inverted cone, which divides the current, and allows the products to pass out on every side. Above the cone is a horizontal plate, projecting on all sides beyond the cylinder it covers, and somewhat convex. This serves to divert any water that may pour upon it, innocuously away. This cover has a space between it and the base of the cone, so that any horizontal air-current striking against the top of the lantern passes through this aperture, meeting less resistance than if it chose the downward direction. As this sweeps away the products of combustion from the top, a gust of wind tends rather to increase the brilliancy of the flame than otherwise.

These lamps have been tested in ships, high towers, express trains, and in every case, successfully. As the carefully-adjusted metal funnel renders a glass chimney dispensable with, there is no part which is liable to damage. The one great point to be observed is keeping the whole case air-tight, except at the legitimate outlets; for, you perceive, when I open the door at the back, be it ever so little, the perfect equilibrium of supply and combustion hitherto obtaining, is disturbed, and the flame wavers and smokes. With this, we must dismiss the lamps, and with them, the animal and vegetal luminants, from which, the petroleum-burning apparatus discussed to-night, affords an apt transition to the mineral kingdom.

General Notes.

Silk-worm Culture in Ceylon.—The *Central Blatt für Textil Industrie* states that the superstitious views of the Buddhists had, until recently, prevented the extension of silk-worm culture in Ceylon. According to the latest accounts, however, this opposition has been overcome, and silk is occupying much attention in several districts. The numerous insects and reptiles of the island have been found to render progress difficult; but it is expected that, by the adoption of such precautionary measures as are usual in tropical countries, the new enterprise will finally be successful.

New York Industries.—According to the census returns of 1880, there were at that time in New York 378,159 men and 135,218 women, making together 513,377 persons, including servants of both sexes, who obtained their living by the work of their hands. The various branches of industry amounted to 218, giving employment to 146,179 men, 71,795 women, and 9,878 children under 16 years of age. The capital engaged in these trades was £36,200,000, the wages amounting to £19,400,000, and the raw material to £57,680,000. These 218 industries were carried on in 11,339 establishments, including 839 boot and shoe factories, 782 baker's shops, 761 tobacco manufactories, 736 clothing works, 460 carpenters' shops, 412 printing offices, 401 plumbers' shops, 229 furniture warehouses, 293 painters' shops, 177 tin-ware factories, and 174 sadlers' shops. A capital of £14,000,000 is sunk in the manufacture of waterproof clothing, and £6,010,000 in the boot and shoe trade, which provides employment for 15,000 persons in 120 establishments. No less than 30,000 tons of raw india-rubber are imported annually into the United States. Combined with other substances, it produces a total weight of manufactured articles amounting to 300,000 tons. The cost of raw india-rubber four years ago was under 2s. a lb., but it has now risen to about 5s. In consequence of this great rise in the price of india-rubber, attempts are made to replace it by other substances, such as celluloid.

Institute of Agriculture.—The Council of this Institute, which has been founded for the purpose of advancing technical instruction upon various sections of agricultural practice, have issued their second annual report, from which it appears that the total number of persons to whom certificates of merit have been awarded, during the present session, is one hundred and three. The arrangements for the next session consist of a course of 280 lectures upon agricultural science, from October 1st to May 3rd, 1884; a course of 60 lectures on poultry, dairy, and bee management, from March 10th to May 3rd, 1884; a course of ten Monday evening lectures on agricultural science, from February 18th to April 28th, 1884. Research committees have been established, and are carrying on their respective inquiries upon root crops, farm seeds, and plant growth. The address of the Institute is South Kensington, S.W.

Chinese Tea Trade.—The returns of the export of tea from China and Japan during the past season continue to show a great decline in the shipments to this country. In the twelve months ending the 31st May, the total consignments to us were in round numbers:—

	lbs.
1882–3	170,000,000
1881–2	164,000,000
1880–1	175,000,000

To the Continent the shipments were—9,360,000 lbs. in 1882-3, as compared with 10,100,000 lbs. in 1881-2, and 7,200,000 lbs. in 1880-1. Accompanying this decline in the supplies of tea which Europe has obtained from China, there has been a large increase in the supplies from India, and the Indian product would thus appear to be gradually ousting that of China from our markets.

Journal of the Society of Arts.

No. 1,602. Vol. XXXII.

FRIDAY, AUGUST 3, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

SOLID AND LIQUID ILLUMINATING AGENTS.

By Leopold Field, F.C.S.

Lecture IV.—Monday, February 19th, 1883.

We now leave that part of our subject pertaining to unmanufactured materials, and come to consider what difference chemical treatment is able to produce in them. As mentioned several times already, spermaceti and wax are incapable of improvement by decomposition, but tallow and palm oil only become true illuminators when chemistry has divested them of their grosser components. It is singular to remark how prominent a part France has played in the history of lamps and candles. We have the Sieur de Brez inventing mould candles; Cambacères, who introduced plaited wick, perhaps as vital and essential an improvement as any; Argand and Carcel, the fathers of the lamp; and last, and greatest, Chevreul, the discoverer of stearine. It is also worthy of note that all the great inventions which confer a lustre on this century took their rise in the period intervening between the first and second great French Revolutions. The steam-engine, the railway, the steamship, the electric telegraph, gas lighting, the penny postage, and the abolition of slavery, are all events in that era. I mention the latter with a purpose, because Chevreul's discoveries have tended more to the bringing about of that blessing than missionary labours or Acts of Parliament. This assertion will be proved as we proceed. For the present we will consider what these labours were. In 1811, Chevreul's researches commenced; his first paper saw the light in 1813. In this he announced that fatty bodies were of a composite nature; that tallow, lard, and other fats were not pure compounds, but, in the first place, *mixtures* of hard and soft materials which, again, were *compounds* of a fatty acid with a substance called glycerine. This discovery is the keynote of the stearine industry; for, until the comparatively unimflammable glycerine is severed from the brilliantly burning fatty acid, and devoted to its own valuable purposes, neither of them can be said to fulfil its legitimate intention. The efforts of all labourers in this field are still directed to the obtaining a fatty acid free from glycerine in the cheapest manner and greatest quantity. Chevreul published paper after paper, attacking and decomposing one fatty substance after another, until, in 1823, he published the whole of his labours under the title of "Chemical Researches on Fatty Bodies of Animal Origin," perhaps as fine a monument of untiring perseverance, combined with supreme skill, as chemistry has to boast of. But, so far, the tendency of Chevreul's work had been entirely scientific, nor had he attempted to obtain any pecuniary result from his labours. From a keen eye like his own, however, it was impossible that the intrinsic value of his discoveries would long remain concealed. Accordingly, in 1825, he, with Gay Lussac, started a factory for the manufacture of stearic acid, under the protection of patents. But chemical knowledge and technical—or rather commercial—success do not always go hand-in-hand. Chevreul's enterprise proved a failure; and it remained for M. de Milly to reap the harvest which the great chemist had sown. In 1832, M. de Milly commenced manufacturing stearine candles near the Barrière de l'Etoile, and produced some very excellent candles which were called by that name. The Société d'Encouragement, of Paris, in the same year, were moved, in consideration of Chevreul's labours, to offer a premium of 4,000 francs to the manufacturer who should produce two tons of candles under the following conditions:—The price not to exceed 9d. per lb.; the light to be, weight for weight, equal in amount and brilliancy to that of wax candles; neither to smell, smoke, nor gutter, and to be hard and dry; the multiplying point not to be below 122° Fahr. Messrs. Motard and Milly were successful in

their endeavours to obtain this prize, up to a certain point. They produced candles complying in all respects with the conditions, except in that of price, which was nearly double the amount stipulated. In awarding a silver medal to the claimants, the Society expressed a hope that the money prize would be carried off.

It is here necessary to consider the results published by Chevreul, and applied by M. Milly. You have heard that oils are divided into "fixed" and "essential," and that the latter are not qualified to be considered as luminants, differing totally in constitution from the former. I may just remark that as nearly every natural product yields a separate definite acid, so also it contains a characteristic essential oil. I need scarcely remind you how keen the sense of smell is, which enables us readily to distinguish the hundreds of different odours we come across in daily life, and nearly each of these is due to an essential oil. But the fixed oils can be defined as compounds of a fatty acid with alcohol, either glycerine, as in true fats, or ethyl, cetyl, &c., in wax. Tallow, the most important, is a mixture of stearine and oleine. By simple pressure the latter separates in the form of a brown oil. This is now extensively used in the art of making butter, but is not to be confounded with the commercial oleine used by soapmakers, which is really oleic acid. Stearine consists of stearic acid and glycerine. Palm oil, which is becoming as important a substance as tallow itself, consists mainly of palmitine, which is palmitic acid and glycerine, For the chemical formulæ of these bodies, I will refer you to the diagrams in Lecture I. In order to effect the sepa ration of these bodies to obtain the palmitic, stearic, and oleic acids in an utilisable condition, three processes are available; the first is that of Chevreul, adopted by M. Milly, called the *saponification* process; the second, perfected by Wilson, is called the *acidification;* and the third, the modification of Tighlmann's invention, called the *high pressure* process. We will take them *seriatim*. The theory of the saponification process is based upon the fact, that glycerine has less affinity for the acids than an alkaline base. Accordingly, if the fat be heated with lime or soda, the glycerine is set free, and a *soap* is formed. If soda be used, the soap is soluble, and, as such, is the ordinary vehicle for removing dirt. But where lime is employed, an insoluble soap is formed. This is the plan adopted for the manufacture of stearine by Chevreul's process. Into a large lead-lined tank, certain proportions of tallow and palm oil are emptied from the original tubs, which are finally steamed. Thereupon a certain amount of slaked lime, varying in quantity with the nature of the fat used, is added, and the whole boiled for some hours with open steam. At the end of the time, the tallow of the acids will have combined with the lime to form a hard substance, technically known as "rock;" chemically, as a mixture of stearate, palmitate, and oleate of lime. The liquid contains the glycerine highly diluted, and is known as "sweet water." The rock is then removed to another lead-lined tank, where it is boiled with strong sulphuric acid. This combines rapidly with the lime to form insoluble sulphate, and the freed acids float on the top. When partially cool, they are run into flat pans, and allowed to solidify. The cakes are placed in horsehair bags, and introduced into the hydraulic press. Here they undergo a pressure at a gentle heat, sufficient to force out the bulk of oleic acid; by this time the cake has assumed a light yellow colour, instead of the original dark brown. The oleic acid still contains much stearine, which is removed by various processes, still the subject of much inventive energy, as the relative prices of stearine and olein being as 50—30, the success or failure of a factory often depends upon the per-centage of stearine obtained.

The cakes are now placed in stronger bags, and subjected to a considerably higher pressure, approaching six tons on the inch, at a temperature of over 120° Fahr. Cast into blocks, they are then ready for the manufacturer. The stearine obtained by this process, as will be seen by the specimens on the table, is beautifully crystalline. It is a mixture of stearic acid and palmitic acid, often called margaric* acid. It is still open to doubt whether margaric acid is a true compound, or simply an alloy of the two other acids. The reasons for believing it to be an independent compound are, that its formula, $C_{17}H_{34}O_2$, is intermediate between those of stearic acid, $C_{18}H_{36}O_2$, and palmitic acid, $C_{16}H_{32}O_2$.

Chevreul first called the fatty acids he discovered margaric and margarous, the latter being stearic acid. Heinty has shown the margaric acid of Chevreul to consist of 90 per cent. palmitic, and 10 per cent. stearic acids. All other saponified margaric acids, so called,

* *Margarita*, a pearl.

have been proved to be different mixtures of stearic, oleic, and palmitic acids. But an actual margaric acid, of the formula $C_{17}H_{34}O_2$, may be obtained by the action of water on cyanide of cetyl—

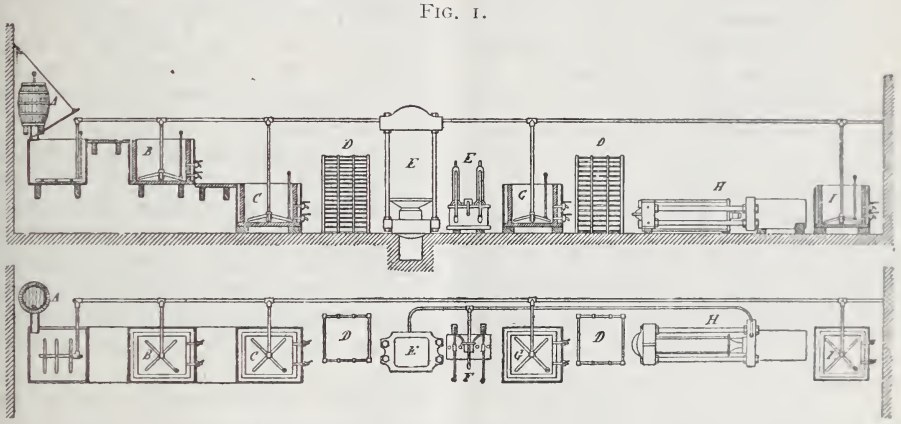
$$C_{17}H_{33}N + 2\,H_2O = C_{17}H_{34}O_2 + NH_3$$

This is a yellowish body, crystallising in fine needles. By re-crystallisation, and partial precipitation, the margaric acid may be made to yield a higher member still, $C_{19}H_{38}O_2$, which has not, I believe, been found in natural products hitherto. The name margarine is, however, too tempting not to be applied, in a good many modulations, to candles of pearly lustre by the makers.

One of the great obstacles to commercial success in the manufacturing of stearine was the difficulty of disposing of the oil, which was a waste product, and would have remained so, but for the wise step of removing the duty on soap. It is now, however, almost as important as the stearic acid, being employed for making what is known as pure oil soap, an article in immense demand among dyers and bleachers.

The next process—that of acidification—requires a short history, by way of preface. Till now, only tallow had been employed for making stearine, though, in 1836, Messrs. Hempell and Blundell took out a patent for making candles from saponified palm oil. These, as you see by this specimen, give a fair light, but are dark in colour and are

Fig. 1.



Apparatus for the Saponification of Stearine.

A, tub from which lime is emitted; B, lead-lined vats with steam-pipe, for boiling fat and lime; C, ditto, to which rock is transferred, and boiled with sulphuric acid; D, rack holding pans for caking mixed acids; E, cold press; F, hydraulic pump; H, hot-press; I, vat for melting refined stearine for casting into blocks.

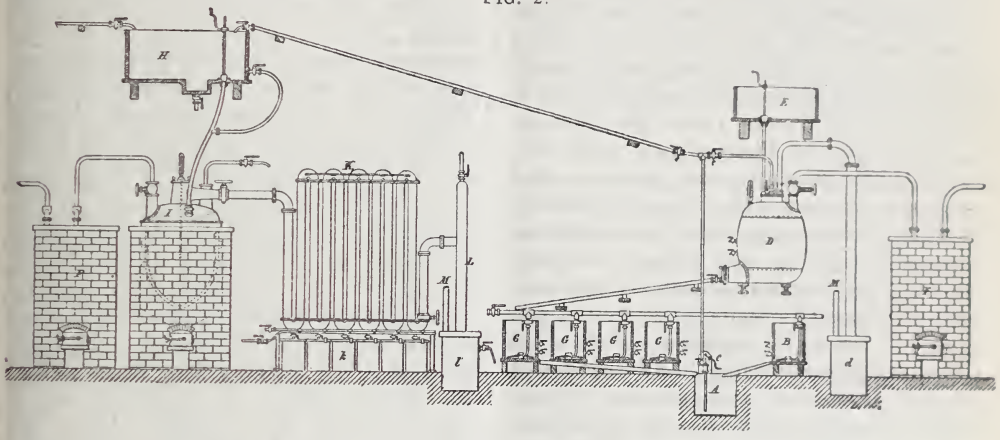
greasy to handle, and never became popular. In 1829, Mr. Soames had taken out a patent for pressing cocoanut oil, obtaining a solid and a liquid. This cocoanut stearine was a decided improvement upon pressed tallow, but the candles made from it still required snuffing, and consequently were never extensively used. The composition of cocoanut oil, as already shown (Lecture III.), differs very considerably from that of palm oil and tallow; the proportion of glycerine is comparatively small, and the fatty acids very numerous; some of them, as *caproic* and *caprylic*, are volatile at low temperatures and give very pungent vapours, especially when the candle is blown out, which, of course, tended to render this candle objectionable. It was not till Mr. Wilson brought out his composite candle, which I have already described, composed of the cocoanut stearine and the new stearic acid, that they became popular. Their sale is still very great, though the composition of the present composite candle differs materially from those first introduced under that name. In 1840, Mr. Gwynne patented a process of distillation in vacuo for fatty bodies, and also for distilling fatty acids, under atmospheric pressure. Though the principle was mainly the exclusion of air from the apparatus and was valuable, the working was not found practicable. In 1842, Messrs. Price and Co.—under the name of W. C. Jones—patented the process of distillation of acids from cocoanut oil alone, and also after combination with lime. Very beautiful

candles were made by this method, but were still subject to the same complaint of those of stearine, namely, of evolving vapours. The candles made of the product of distillation from the cocoanut lime soap were free from all defects, but their cost was far too great. Various experiments were tried, and patents taken out; but we cannot stop to consider any till we reach the patent of Messrs. Wilson and Gwynne, in 1843, which embodied the suggestion of M. Frémy, to heat oils with acid instead of alkali; only, instead of following his recommendation that the vessel should be kept as *cool* as possible, the patentees recommended a high temperature, and distillation under superheated steam. The process will be best understood from the actual description. Tallow oil is subjected to the action of strong sulphuric acid at a very high temperature, in the proportion of 6 tons of the oil to 7 cwt. of acid. By this means the glycerine is converted into sulpho-glyceric acid, with evolution of sulphurous acid, and a certain amount of carbon. After the acid treatment, the black mass in the vessel looks anything but promising. A little washing, however, frees it from the residual charcoal and acid, and it is then transferred into a still, into which superheated steam plays, and this, with the aid of gentle "bottom heat," distils over the acid. Here is the raw palm oil of a golden yellow colour. Here the black mass produced by the acid treatment, and this firm white substance the product of distillation. In the still a black thick pitch remains, known commercially as palm pitch. What has come over is pure palmitic acid. The medium runnings of the distillate are the best. The first and last are not so good, and are used for inferior candles. From this palmitic acid the finest composite candles are now made. Price and Co. subject their distillate to hot pressure, and obtain the "Belmont Sperm" thereby. You will remark the beauty of their appearance, and the clear lustre of the flame. I have here burning, side by side, a candle of tallow, and a candle of stearic acid, with equal wicks, and you will perceive at once the difference made by the exclusion of the glycerine. I have forgotten to mention, in the description of the palm oil, the kernel of the nut, from which is obtained a very large amount of oil, equal to, if not exceeding, the quantity produced from the fruit. The composition, however, is quite different, being, in fact, almost identical with that of cocoanut oil, which it replaces in many instances, especially in the manufacture of soap, for which both these oils are abundantly employed. So much for the saponification and distillation processes, of the details of which these fine diagrams and appended explanations will give you a more complete idea. Mr. Tilghmann, in 1854, took out a patent for the separation of fats into acids, and glycerine by heating with water under pressure. He suggested pumping the mixture of fat and water through a coil heated to a temperature exceeding 800° Fahr., and at a pressure of 2,000 lbs. to the inch. Messrs. Wilson and Payne patented a method by which superheated steam passed into the fat at ordinary pressure effected the separation, and distilled both acids and glycerine. By re-subjecting the latter to this process, Mr. Wilson obtained the beautiful glycerine for which Price's Patent Candle Co., have so high and just a reputation. I cannot dilate as I should like to upon the uses and beauties of this beautiful alcohol. They form part of that branch of chemistry known as saponification, a wide reaching and deeply interesting subject. However, Mr. Tilghmann's idea has been amplified, and on the Continent a great part of the stearine is made by what is called the autoclave process. The tallow and palm oil are introduced into a stout copper vessel provided with a stirrer, into which superheated steam is passed till the pressure reaches 250 lb. on the inch. After several hours agitation at this pressure, the separation is complete. Each of these methods has its particular advantages, and is applied to certain specialities of stearine, in the choice of which experience is the only guide. I have on the table samples of candles produced by all the methods I have named, and many more (which will be particularised in the last lecture on candles). I cannot conclude without drawing your attention to the great results which have followed the discoveries of Chevreul and Wilson. Had it not been shown that by these processes the worst and darkest greases can be forced to yield a clean and beautiful substance, palm oil would have been almost useless to the candle-maker. As it is, over forty thousand tons are imported annually into England, and, no doubt, far more into the Continent and America. The kings of the countries where the palm tree grows find that the labour of their subjects, in collecting the fruit and extracting the oil, is far more remunerative to them than the selling of these subjects into slavery. Being as keenly alive to their own interests as any white men can

be, they have become humane as a matter of business. By encouraging the influx of European goods in exchange for their native productions, they have brought about their own civilisation far more rapidly than could have been effected by the simple spiritual pressure of missionaries unendorsed by self-interest. There are many other varieties of tree oils, such as the Cahoun palm, the Bassia butter, and others of which I have already given the names and compositions, and of which you see specimens on the table. We must now dismiss the vegetable and animal kingdoms, and devote the next lecture to the consideration of those products of a bygone world — paraffin and petroleum.

Those for whom the history of the stearine industry possesses sufficient interest would do well to read Mr. G. F. Wilson's excellent lecture on the subject, delivered before the Society of Arts, in 1852, and a paper read a short time subsequently, in amplification of the lecture. For the major portion of the above information I am indebted to these records, written by one who should, perhaps, rank next to Chevreul for the share he has taken in promoting this gigantic industry.—L. F.

FIG. 2.



APPARATUS FOR ACIDIFICATION AND DISTILLATION OF STEARINE.

A is a tank into which the material to be operated upon is melted from the casks by means of a steam-jet inserted in the bung-hole. B is one of a series of lead-lined tanks for boiling the material before passing it into the copper vessel D. C is the pump used for the double purpose—firstly, of charging the copper vessel D with the material through the cock *c*; secondly, of pumping it after it has been acidified and washed, through the cock *c c* into the grease-charge tank above the still. D, the copper vessel, is the "Acidifyer," made of stout copper, supported either on wrought-iron girders or brickwork. It has the following fittings, viz., a valve with pipe for the admission of superheated steam; a copper pipe, fitted with a water shower pipe for condensing the vapours in the vessel, produced by the acidifying process; a thermometer for the guidance of the operator, and a gun-metal cover at the lower side for cleaning out; to this cover is affixed a cock, through which is drawn the acidified materials into the washing vats. E is the acid tank. F is the superheater, the design of Mr. Ed. Field, C.E. G G G G are the washing vats. H is the charge tank for feeding the still. I is the still. K is the refrigerator. *k*, one of the series of iron tanks containing the copper cooling coils. L, the essence tank, fitted with an improved patent safety condenser, which prevents the possibility of any vapour passing away uncondensed. M, a pipe for conveying gas to be burnt in the flue. This description of apparatus is made in several sizes.

ADDENDUM TO LECTURE II.

Since the publication of Lecture II., Professor Thiselton Dyer has kindly called my attention to several points where my statements concerning the waxes need emendation; I therefore add the following particulars:—

Chinese Wax (*Chung-peh-la*).—This wax had not assumed commercial importance in China till the thirteenth century, and, till a much later date, was used only by those of the highest rank. The cultivation of the insect is now an industry next to silk in importance. The annual value of the amount produced is computed at about £600,000. Concerning the name and the nature of the insect which produces the wax, and the tree on which it grazes, there has been much doubt. This is partly due to the fact that several other species of

coccus produce kindred but dissimilar substances. Thus, the *Coccus ceriferus* produces a substance called white lac, a brittle semi-transparent body, with appearance and properties by no means resembling *peh-la*. Mr. Lockhart, of Shanghai, has given much information concerning this insect, and Mr. Westwood reported upon the specimens of insects sent over by him, and proposed the name of *Coccus sinensis* for the new insect. The form of the *coccus* is not unlike that of the small wood-louse. The young are probably the real producers of the wax. As regards the nature of the tree upon which the insect feeds, and the branches of which it encrusts with wax, the statements are also conflicting. From a Chinese drawing with names appended, we may judge the tree to be of the species *Ligustrum lucidum*, although another drawing, as pointed out to me by Professor Dyer, would show that the insect also affects the *Fraxinus Chinensis*, or China ash. In my second lecture, you may remember, I quoted *Rhus succedanea* as the most likely forage, inasmuch as that tree yields Japanese wax, but to this Professor Dyer objects the dissimilarity of constitution between the Chinese and Japanese wax, the latter of which you will remember is a palmitate of glycerine; the former was cerylic cerotate. But as the acids are of the same series, and Professor Maskelyne has obtained palmitic acid by the saponification of Chinese wax, I ventured to think that the predetermination of the plant to form wax might be carried out differently in the insect to the fruit. But as it is very doubtful whether the insect feeds at all upon the *Rhus succedanea*, my theory must be received with extreme caution. Professor Maskelyne's paper, which gives the most comprehensive account of the chemistry of *peh-la*, is to be found in the *Quarterly Journal of the Chemical Society*, vol. v. p. 24. Sir Benjamin Brodie (Transactions of the Royal Society, 1848, p. 159), also gives an account of its composition. In the museum of the Pharmaceutical Society there is a twig of the *Fraxinus Chinensis* coated with the wax of this insect, and Mr. Westwood's description is published in the *Gardeners' Chronicle*, 30th July, 1853. Mr. Fortune obtained a plant through some Catholic missionaries from the province of Szc-tchuen, which has much similarity to some species of *Fraxinus;* and in "Hanbury's Science Papers" at pp. 60 and 275, will be found a copious account, containing nearly all that is known concerning this insect, with woodcuts, &c. Concerning the Japanese wax, Professor Dyer informs me that it is not produced from the *root*, as I stated, but from the *fruit* of the *Rhus succedanea*; and in the North of Japan, from the berries of the varnish tree, *Rhus vernicifera*. It must be observed that the varnish is not made from the wax. The latter is yielded by the berries on boiling, to which process they are subjected several times, with pressure in bags, a small amount of oil having been added to render the wax more fusible. The varnish flows from incisions made in the stems of this species of *Rhus*. Both these trees, and several other wax producers, are in the Kew Botanical Gardens.

It will be observed that I have not mentioned the properties of the whale, seal, and other oils of that species (manatee, dugong), &c. Mr. A. H. Allen, on the evening of my third lecture, read a paper before the Society of Chemical Industry upon these oils, in which he points out that they contain a large proportion of free oleic acid, and suggests that to the presence of this a great deal of the clogging of machinery lubricated therewith is due. He also thinks that sperm oil should, from its constitution, like sperm itself, be classed rather with the waxes than with true oils; and the bottle-nosed whale oil closely resembles that of the cachalot. As regards the oil from both these whales, Mr. Allen endorses my statement that it produces sperm from whatever part of the body it be taken. He attributes the difference of properties in the two oils, as commercially known, to the fact that while the sperm oil is boiled down on the ship, and hence freed from the fibre soon after death, the bottle-nose oil has been prepared from boiling the blubber after it has arrived in England, when it has undergone putrefaction to a more or less considerable extent. The northern and southern whale oils he regards as triglycerides. One important difference between the whale and sperm oils lies in their specific gravity; that of the whale being ·880, and that of the sperm ·914, which would strengthen the presumption of the waxy nature of the latter. Two oils known in the market as shark-liver oil, and African fish-oil, are of very light density, and Mr. Allen expects that they will prove to resemble sperm oil in constitution; but hitherto they have resisted all attempts at saponification. His paper is full of interest, and, containing information almost entirely novel, is well worthy of study by those interested in the subject.

Miscellaneous.

PATENT LAW.

The Patent Bill, after having passed the Standing Committee on the 9th July, has not since made any further progress. The alterations effected in committee are summarised as follows by *The Times* :—

"The Bill, as amended by the Standing Committee, has been reprinted, ready for presentation to the House. In its new form the part of it relating to patents for inventions shows many important alterations, though in details only, the amendments having scarcely touched any of the main principles of the original measure. The improvements which have been made are for the most part due to the efforts of committees of the Society of Arts, the British Association, and the Institute of Patent Agents, all of which bodies had interviews with Mr. Chamberlain, and were also ably represented in the Grand Committee by Sir John Lubbock and other members. Mr. Samuelson, Mr. Hinde-Palmer, and Mr. Anderson also were active in introducing amendments.

"As regards the method of application for patents, no great changes have been effected in the original scheme. Provision is made for joint application by several persons, of whom one or more may be the actual inventor, and the rule that the provisional specification was to contain precise claims has been struck out. The proposed system of examination into applications has been modified in several particulars. The examiners are not to inquire into 'subject matter,' that is to say, to report whether the invention is a proper subject for a patent; they are only to see that the proper forms are complied with, and that a proper description of the invention is supplied (strangely enough the examination into this point is still limited to the provisional instead of being extended to the complete specification). They are, however, to report if they find two applications for protection for the same invention, and in such a case both applicants are to be informed. Provision is made for the keeping secret of the examiners' reports, even in the case of an action at law.

"The provisions for opposition to grants of patents are the same as in the original Bill, but opposition is limited to two grounds (1) that the person opposing has been robbed of the invention; (2) that there already exists a patent for the same invention. It will be noted that this last provision practically opens up the whole question of novelty, and might enable a rival trader to force an applicant to defend the novelty of his invention in its very earliest stages. In the case of a capitalist pitted against a poor inventor, it is easy to see the hardship of such a proceeding.

"No changes are made in the fees, but an alternative scale is given under which they may be paid annually. This scale is so arranged that a patentee whose patent lapsed at the seventh year period would pay slightly less in the annual fees than if he paid a lump sum in advance.

"The practice of 'racing for the seal,' as it is called, that is, the attempt by a later applicant to get his patent sealed before an earlier applicant, and, therefore, effective against him, is clearly done away with in the amended Bill. In the Bill as drafted this was not quite certain.

"The question of amendment is treated more liberally than it originally was, rather wider powers being given to the patentee.

"A new clause has been introduced rendering patents effective as against the Crown. This, it will be remembered by those who followed the account of the proceedings in Committee, was carried against Mr. Chamberlain, and perhaps there are still hopes that this clause will not become law, because no corresponding alteration has been made in the form for the grant of a patent in the schedule. There the rights of the Crown are still maintained intact. The clause itself is similar to one in Sir John Holker's 1879 Patent Bill.

"In the section devoted to legal proceedings, there is inserted a new clause providing a remedy for groundless threats of such proceedings. In the miscellaneous section also there are one or two fresh clauses. Amongst these will be found provision for the case of an inventor who dies without applying for a patent, while another sub-section instructs the Patent-office to keep on sale copies of specifications of all existing patents. This clause would be improved by the omission of the word 'existing,' as it is difficult to see why the office should not resume the practice, discontinued a few years ago, of keeping in print all specifications alike.

"The alterations in the governing body of the Patent-office, proposed in Committee, were not pressed in consequence of Mr. Chamberlain's opposition, but the various modifications in the system, under which much originally left to the law officers would now be transferred to the Controller, will probably, to a great extent, meet the wishes of those who were anxious that the importance of the department should be secured by investing its head with, as far as possible, an independent authority. The autocracy of the Controller is, however, tempered by a provision that he is not to exercise his powers adversely to an applicant without first hearing him.

"One more provision there is of considerable importance. In case of international arrangements being effected for the protection of inventions, a foreign patentee is to have priority over other applicants, if he applies within six months of the date of his foreign application. This rule is, however, only to apply to foreign States with which international arrangements have been made. In all other cases it may be assumed that the legal interpretation of invention will still apply, and that the man who imports an invention at his own cost and risk from

the distant shores of France or Holland will still, in the eye of the law, be the 'first and true inventor.'

"There are many other minor alterations, but probably the above include the most important of those dealing with patents."

The clause relating to the printing of specifications has been made the subject of a memorial addressed to members of Parliament, urging the importance of all patent specifications being printed and kept in print. Under the Bill it is proposed to print the specifications, but only to keep in print those relating to patents actually existing. The following is the full text of the memorial:—

"6, Great George-street, Westminster, S.W.

"20th July, 1883.

"DEAR SIR,—We learn through the daily press, that although in committee on the new Patent Bill it was strongly urged that all specifications should be printed and kept on sale, as at present, it was stated by Mr. Chamberlain that this would cost too much.

"We would beg to call your attention to the fact, thoroughly acknowledged by all who have to do with specifications of patents, viz., judges, barristers, solicitors, inventors, engineers, and, we may add, those of the public at large, who require to know what is in a specification, that the printing and keeping all specifications on sale has been one of the most useful improvements introduced under the Patent Law Amendment Act of 1852, since it has had the effect of spreading a knowledge of inventions in a most beneficial manner, and at a cheap rate. Some specifications have been run through three, four, five, and even seven editions.

"It is absolutely necessary, in a patent case in Court, that printed copies of all the specifications referred to should be in the hands of the parties, and the drawings should be of the same size as the original drawings lodged by the patentee; very small copies of them are comparatively useless, as has been proved several times lately in Court, when, notwithstanding the use of magnifying glasses, parts could not be made out.

"The enormous surplus of more than a hundred thousand pounds per annum over and above the cost of printing all specifications, shows that this necessary work can well be afforded.

"Abstracts and abridgements are useful for their purpose, but are wholly useless to inform one what is the exact thing absolutely described and claimed by a patentee. We trust that due attention will be given to this matter, and that the printing of all specifications, and the keeping of them on sale, will be decided on, as it is certain that it will be found necesary in the interests of the public.

"If the specifications could not be bought, parties would have to examine the original specifications, and a room as large as the present library would not be large enough for the readers, many of whom would have to wait days before they could see a popular specification.

"We are, dear Sir,

"Yours truly,

JAMES BRUNLEES (President of the Institution of Civil Engineers),

THOMAS HAWKSLEY (Past President of the Institution of Civil Engineers, and of the Institution of Mechanical Engineers),

WILLIAM H. BARLOW (Past President of the Institution of Civil Engineers),

P. G. B. WESTMACOTT (President of the Institution of Mechanical Engineers),

JOHN RAMSBOTTOM (Past President of the Institution of Mechanical Engineers),

WILLIAM SIEMENS (Past President of the Institution of Mechanical Engineers, and of the Iron and Steel Institute, and Chairman of the Society of Arts),

FREDERICK BRAMWELL (Past President of the Institution of Mechanical Engineers, and Past Chairman of the Society of Arts),

H. TRUEMAN WOOD (Secretary of the Society of Arts),

HENRY BESSEMER (Past President of the Iron and Steel Institute),

WARREN DE LA RUE (Past President of the Royal Astronomical Society, and of the Chemical Society),

F. W. WEBB (Locomotive Superintendent, London and North-Western Railway),

J. TOMLINSON (Locomotive Superintendent, Metropolitan Railway),

W. ANDERSON,

JAMES NASMYTH,

JOHN HOPKINSON,

JOHM IMRAY,

THORSTEN NORDENFELT,

SAXBY AND FARMER,

E. A. COWPER (Past President of the Institution of Mechanical Engineers)."

TECHNOLOGICAL EXAMINATIONS.

The Report of the City and Guilds Technical Institute on the results of the Fifth Examination in Technology, held under the direction of the Institute, has just been issued.

According to the returns received in November last, the number of students who were receiving instruction in the registered classes of the Institute was 4,052, showing an increase of 585 on the number of registered students at the corresponding period last year.

An increase is shown in the general results of the recent examination as compared with those of any former year. Last year, 1,972 candidates were examined, of whom 1,222 passed. This year 2,397 candidates were examined, showing an increase of 425, of whom 1,498 passed.

There has been but a slight increase in the number of centres in which the examinations have been held. This is attributed partly to the greater stringency of the conditions for the registration of teachers, and partly to the fact that examinations were already held last year in the chief manufacturing centres of the kingdom. Of these centres, Glasgow has sent up 123 successful candidates, Bolton 117, Manchester 76, Leeds 64, of whom 43 have come from the Yorkshire College, Bradford 51, Huddersfield 47, Preston 46, Rochdale 46, and Oldham 42.

Only one subject has been added to the examination this year, that of "Milling and Flour Manufacture." In this subject 32 candidates presented themselves, of whom 22 succeeded in satisfying the examiner. In "Jute Manufacture," 5 candidates presented themselves this year for the first time, of whom 3 passed. In four subjects, "Illuminating and Lubricating Oils," "Lace Manufacture," "Silversmiths' Work," and "Mechanical Preparation of Ores," no candidate was examined. Of the 2,397 candidates who presented themselves, 407 were examined in honours, of whom 292 passed, and 1,990 were examined in the ordinary grade, of whom 1,206 passed. The per-centage of failures on the results of the examination in all the subjects has fallen from 38 per cent. in 1882 to 37·5 in 1883.

In twenty-two subjects there has been an increase in the number of candidates, and in the remaining fifteen subjects, which are almost exclusively chemical subjects, there has been a slight falling off. This, it is remarked, is to be regretted, as it is especially in the knowledge of the higher branches of technical chemistry that Englishmen are found to be deficient, as compared with the Germans or Swiss.

Considerable difficulty is still experienced in finding competent teachers for technical classes, possessing both a practical and a scientific acquaintance with their subject. It is anticipated that this difficulty will be somewhat lessened when the Central Institution is in working order, where courses of instruction, adapted to the requirements of technical teachers, might be given with advantage during the summer months.

Of the total number, 1,498, of successful candidates, 1,161 came up for examination this year for the first time, and of the remaining 337 who had been previously examined, 141 succeeded in obtaining a certificate in a higher grade, 68 succeeded in obtaining a higher place in the same grade, and 128 passed in the same grade and class as they had previously passed. In accordance with rules 5 and 37 of the programme, the names of these 128 candidates are not included in the pass list.

As several of the Institute's candidates have gone up this year for the Science and Art Department's examination, the exact number of candidates qualified to receive the full technological certificate cannot at present be ascertained. It is, however, quite certain that the number is still comparatively small, and that a large majority of the candidates have not availed themselves to the extent which is desirable of the facilities offered to them by the Department, of obtaining adequate preliminary instruction in pure science. Judging from the statements of the candidates themselves, as shown on the forms which they are required to fill up at the time of the examination, it would appear that about 420 of the successful candidates will be qualified to receive the full certificate, and of these 54 will be found among the list of prize winners.

143 prizes have been granted, including 129 money prizes, 48 silver medals, and 95 bronze medals. Looking at the general results of the examination, it appears that, whilst there is still a deficiency of scientific knowledge and of skill in drawing among the candidates, a decided improvement has been shown in most subjects in the quality of the work sent up for examination; and it may reasonably be hoped that, if the present standard of examination is maintained, teachers and pupils will be induced to persevere in their efforts, and that the quality of the candidates' work will still further improve.

As regards the cost of the recent examination, it is estimated that a sum not exceeding £1,309 will be paid to teachers on results. The cost of the prizes will be about £500, including the sum of £436 given as money prizes. The fees to be paid to the examiners will amount to about £420, and those to secretaries to about £110, and the cost of printing and advertising may be reckoned at about £450. Adding these sums together, the total cost of this year's examination may be estimated at £2,789. This is £328 in excess of the estimate of last year's examination. The actual cost of the examination in 1882 was £2,379 12s. 11d.

FISHERIES OF RUSSIA.

Consul-General Standon says that, prior to 1855, no attempts at fish culture had been made in Russia. Since that date, many establishments have been opened for artificial breeding, and the interest in the art is steadily increasing, as is shown by the statistics of one of the leading institutions. This establishment sold, from 1871 to 1880, fertilised trout and grayling spawn amounting to £12,500, and young fish of the same species to the amount of £2,400, the average annual sales of spawn amounting to about £1,300, and of fish, £300. In 1881, the spawn sold realised £3,000, and fish £700. The erection of still larger establishments is projected by the Archimandrate of the Solofski Monastery in Solofski, and by the committee of the Astrakhan Fishing Union, who have determined to erect an establishment on a Volga steamer for the cultivation of sturgeon and white fish, £7,000 having been appropriated for this purpose. Among the natural resources of Russia, fish take an important position, and the following are some of the leading varieties found in the various fishing districts. In the basin of the

White and Arctic seas, the smelt, salmon, cod, flounder, turbot, shark, sterlet, and Siberian sturgeon are found; and as bait the *Mallotus articus* and the *Amodytes laucea* are used. In the basin of the Baltic Sea, the smelt, salmon, cod, flounder, herring, eel, and sturgeon are found; in the basin of the Black and Azof seas, the sturgeon, Caspian herring, anchovy, carp, barbel, and flounder; in the basin of the Caspian Sea, the sturgeon, Caspian herring, white fish, salmon, silurus, carp, and barbel. Besides the above, there are several species which, from their general dissemination, are of importance to the fishing industry, namely, the perch, *Perca fluviatilis*, which extends to the sixty-ninth degree of north latitude, the *Acorina cornua*, and the *Lota vulgaris*, which, excepting in the southern part of the Caspian Sea, are found everywhere; the trout, *Salmo fario*, which abounds in the smaller streams of all the basins; and the *Pelecus cultratus*, which is found in the Baltic, Black, and Caspian Seas. The northern and southern seas, though possessing a few varieties in common, are directly distinguished from each other by the predominating species; the northern seas are rich in salmon, the southern seas in sturgeon varieties. To the present time no diminution in the abundance of fish is noticeable, except in the upper and middle sections of the rivers. The lower reaches are still rich in fish, and in some instances, such as the Volga delta, the Kur and Siberian Rivers, still maintain a primeval abundance. The yield of the northern seas, the Siberian coast excepted, is estimated to be worth £160,000. On the Murman coast, between 5,000 and 6,000 tons of cod fish are annually taken, also 3,600 tons of herrings of all kinds. The White Sea yielded about 3,600 tons of other fish, so that the northern waters yield in all about 18,000 tons of fish. The value of the catch in the Baltic Sea is about £100,000 annually, though the quantity is smaller than that of the northern seas. In Lake Peipus, about 5,400 tons of smelt are annually caught. The Caspian Sea and its tributaries, together with the Ural, Terek, and Kur Rivers, and the Volga delta, yield about 198,000 tons annually, with an estimated total value of £1,050,000. A report from the Governor of Astrakhan, for 1880, states the exports to have been 252,150 tons, with a total value of £2,494,000, and recent statistics gives 320,902 tons as the total export, and this is exclusive of the export to the Caucasus, Orenburg, &c., and the consumption of the inhabitants, so that the actual yield would be about 450,000 tons annually. The sea of Azof, and the Don and Kuban, yielded about £400,000 worth of fish, according to estimate made some few years ago, but, at the present day, the approximate yield is 180,000 tons. The Black Sea and tributaries hardly yield more than £10,000 worth. In Russian water are found a number of mammals, from which tram oil is obtained. In the Northern oceans there are several species of whales, many being of a highly prized description. In the whale fishing industries, Norwegians are chiefly engaged, and they take annually about 150 whales, which yield nearly £15,000 net profit. The secondary products of this fishery, such as whalebone, &c., defray all the expenses, so that the oil obtained is pure gain. Many walruses are found in Nova Zembla, Vaigatsch, and Kolgnzeff. White dolphins and seals are found in the Northern Ocean and White Sea, and in good years sufficient numbers are taken to yield from 1,260 to 1,440 tons of oil. In the Baltic Sea and Lake Ladoga a few seals are also taken, yielding about twelve tons of oil annually. The Caspian Sea is much richer in seals than either of the foregoing. According to recent estimates, there were 955,959 seals sold in Astrakhan from 1867 to 1873, or 136,994 annually. During the same period there were 11,412 tons of oil sold. In the preparation of train oil, all fish of the commoner descriptions is used, while only the internal organs of the more valuable fish are employed. In the northern waters, where there is a large catch of codfish, the oil is made wholly from their livers. In the Caspian Sea, this industry is carried on on a very large scale, but with the increased demand for food fish, the price increased, and species which were formerly used for their oil are now consumed as food, so that the quantity of oil produced is less. Of the Caspian herring, which was formerly taken only for its oil, the catch was about 58,500 tons, representing about 130,000,000 herrings, which yielded 2,760 tons of oil. In 1855, they began to salt these herrings, 10,000,000 being salted down in this year. In 1856, 20,000,000 were salted; in 1857, more than 50,000,000; in 1871, nearly 140,000,000; in 1872, about 160,000,000; in 1873, 180,000,000; in 1881, 250,000,000 of herrings were caught, of which but very few were used for the production of oil.

AN ELECTRIC LAUNCH.

The Electrical Power Storage Company have lately, in co-operation with Messrs. Yarrow and Co., brought out an electrically propelled launch, which has been specially built for its intended purpose, and is, therefore, an improvement on the little experimental launch, *Electricity*, whose appearance on the Thames was first described in the *Times* of the 29th September last.*

The following account of this craft, which is now on her way to the Electrical Exhibition at Vienna, is taken from *Engineering*:—"It is constructed of galvanised steel, and is 40 ft. in length by 6 ft. beam, and draws 2 ft. 9 in. of water. Discarding the intermediate appliances of belts and countershafts employed in the first experiment, they have connected the axis of the dynamo machine—which has been lent by Messrs. Siemens Brothers, and is of the type known as D_2—directly to the propeller shaft, so that

* *Journal*, vol. xxx., p. 1033.

he two run at the same speed, and thus the whole machinery is comprised within the smallest possible ompass. The reversing of the motor is effected by neans of two pair of brushes, one for the backward nd one for the forward motion. These are arranged n two rocking levers, there being one brush of each air on each lever; when the levers are vertical, both ets of brushes are clear of the commutator, but hen they are inclined by means of a spring handle o the right (say), the upper brush of the left lever nd the lower brush of the right lever come into ontact with the commutator, and the boat goes head; when inclined to the left, the upper brush of he right lever and the lower brush of the left come nto operation, and the boat goes backwards, the iameter of commutation having been angularly dis-placed 70° or 80°. Cords are led from the commu-ator handle to the steersman, so that he has the whole of the machinery under his control.

"The launch carries eighty accumulators of the Faure-Sellon-Volckmar type, each containing a stored orce equal to one horse-power hour; sixty-five are sed at once, the remainder being in reserve. The dynamo is capable of transmitting from seven to ight horse-power, and hence the boat can, if needed, un at full speed for ten hours, but, as is well known, t is not desirable to entirely empty the accumulators. At half-speed a much greater distance could be tra-ersed. The battery boxes stand along the keel nder the floor, so that they, as well as the dynamo, re entirely hidden, while at the same time they serve excellently as ballast, the total weight of the boat without passengers being four tons. Thus the whole space is available, none of it being taken up, as in he usual launch, by engine or boiler, and, conse-quently, a boat 40 ft. in length equals in capacity one o ft. or 12 ft. longer, while every part is equally greeable, and no inconvenience is felt from smoke, cinders, or the smell of oil. The speed of the launch has been tested with great accuracy at the measured mile, and has been found to be 8½ statute miles, quite equal to that of her class. On Monday, 16th July, she carried a company of twenty-four gentle-men from the Temple Pier to Greenwich in forty minutes, having the advantage of the tide, and later in the day she brought them back, both journeys being performed most successfully.

"At present, of course, electrically propelled boats are to be classed among luxuries, but people who keep steam pleasure boats do so for enjoyment, and not upon commercial principles. If it were not that trips on the upper parts of the river are taken among such beautiful surroundings, the inconveniences arising from smoke and smuts would soon bring them into discredit, and, as it is, they often detract from the pleasure. If Messrs. Yarrow go into the matter boldly, and provide facilities for the renewal or exchange of batteries at two or three places above Richmond, there is no doubt that their boats would become common. The saving of skilled attendance is in itself a great recommendation, while the feeling of relief that attends the absence of the usual small boiler, often with insufficient water space, and a feed pump liable to go wrong, is a most important gain in an excursion which is undertaken for pleasure."

COTTON-SEED OIL.

Mr. P. L. Simmonds alluded, in his paper on the "Utilisation of Waste" (see *ante*, Dec. 22, p. 104), to the use of cotton seed for the extraction of oil since 1860. Some further particulars are given in a report on the industries of the State of Georgia, quoted in the *Gardeners' Chronicle*. Year by year, the great commercial value of cotton seed has been gradually developed. A great authority has stated that if cotton could be grown in the Northern States, it would be grown, if only for the value of the seed alone. It yields an oil which is largely used as a substitute for lard, and is largely sold for exportation to France and Italy for the adulteration of olive-oil, while the cake finds a ready sale at home and abroad as food for cattle and as a fertiliser. For every bale of cotton grown there is half a ton of seed, and if the crop of the present season yields but 6,500,000 bales, of which there can be no reasonable doubt, there will be 3,250,000 tons of cotton seed. The oil-mills pay 12 dols. a ton for seed delivered at a railroad station or a river landing. Planters ordinarily put aside from 40 to 50 per cent. of the seed for planting; this would leave 1,630,000 tons as the marketable crop of the year; but as many planters live far away from railroad stations or navigable rivers, and the trans-portation facilities of the South are limited, 12 dols. per ton to them would leave no profit, and the seed is therefore used as a fertiliser, so that the actual quantity placed on sale may be put down at less than 500,000 tons. It is estimated that a ton of seed yields from 28 to 32 gallons of crude oil, worth 45 cents a gallon; 750 lbs. of oilcake, worth from 22 dols. to 24 dols. a ton, and about 20 lbs. of lint-cotton, worth 6 cents per lb. The hulls furnish more than sufficient fuel for the mills. The demand for the oil and the cake has grown enormously during the past few years. Until recently, the demand was almost entirely from Europe; but during the past year the New England States alone took 15,000 tons of cotton seed meal (the oilcake ground), and the lard-packers of the West are now largely using the refined oil, which is worth about 60 cents per gallon, to mix with lard, which sells for 12 cents per lb., or 90 cents per gallon. The prejudice against the use of the oil for domestic purposes is fast disappearing, and refiners now sell it largely for cooking purposes. In the New England States, the cotton-seed meal is used as cattle food, the cattle being penned, and the manure utilised as a fertiliser; while in the South it is in most instances applied direct to the ground, or in combination with other fertilisers. The crop of cotton seed of this State, for the year 1882, is esti-mated at 450,000 tons.

General Notes.

Paper Mills.—With respect to the statistics of the paper mills of the world (see *ante*, June 22, p. 792), it has been calculated that to make the 959,000 tons of paper per annum for the world, would require 430 days' medium flow of water down the River Thames; or, 1,432 days' metropolitan water supply.

Ensilage in America.—A successful experiment is officially recorded from Savannah, in which it is stated that the proprietor of a dairy farm in the western part of this State during the summer packed in his *silo* some tons of pea-vines, and on opening it at the end of November, he found the forage in excellent condition. It was given to the cows, and they preferred it to any other food.

The French Woollen Trade.—According to a statement published in a French newspaper, the imports of wool into France have diminished about 4 per cent. for the first four months of the year, as compared with the same period in 1882, when they represented a value of £5,000,000. The imports of woollen manufactures have decreased from £840,000 to £740,000 for this portion of the year. The exports of woollen goods show a decrease of only £70,000 on the £5,750,000 of last year, at the same time. In woollen yarns, the fall is much more appreciable, being from £500,000 to £360,000.

Industry of the Vosges District.—According to statistics published in the French press, there are, in the department of the Vosges, 3,651 establishments, occupying 18,956 men, 11,530 women, and 2,345 children. In addition to this large body of workpeople, there are many occupied at home in embroidery, lace-making, straw-hat manufacture, and other branches of industry. Hand-looms are numerous in the mountainous districts. There are 42 cotton-spinning and doubling mills, and two waste-silk spinning mills; there being occupied in these branches 429,462 spindles. There are 104 weaving mills for cotton, 75 for wool, and four for linen. The looms contained in them number together 18,638, and there are, in addition, 3,305 hand-looms in weavers' houses. The embroidery and lace branches give domestic employment to 3,900 workpeople.

Waterproof Clothing.—For some time past the Belgian War Department has conducted a series of experiments at Valvorde, on the waterproofing of soldiers' uniforms by means of liquid alumina. With respect to the hygienic side of the question, the medical authorities have satisfied themselves that the articles of dress thus treated permit the perspiration to pass off freely, and chemical analysis has proved that the preparation used in no way injures the materials, or destroys their colour. More than 10,000 metres (10,936 yards) of materials, re-dressed two or three times over, notwithstanding the rinsing and washing to which they have been subjected after having been soiled, and after constant wear, remained perfectly waterproof. The only drawback to the process appears to be that it is not very economical, and, to ensure the desired result, must be conducted on a large scale, which requires a considerable amount of plant. The following, according to the *Journal d'Hygiène*, is the process employed:—Acetate of alumina is obtained by making solutions of equal parts of alum and acetate of lead in separate vessels, and then mixing them together. Sulphate of lead will be thrown down, leaving acetate of alumina in solution, which must be decanted. The materials to be waterproofed are soaked in this solution, and then withdrawn without being wrung, and dried in the air.

Locusts.—The districts of Matheran and Mahableshwar, in the Bombay Presidency, according to *The Colonies and India*, have been suffering from an invasion of locusts, huge swarms of which have settled on the trees, which appear to be covered with red foliage and clusters of red flowers during the occupation, but when abandoned, are nothing but bundles of bare twigs. While the locusts are on the wing, it is difficult to make any impression on them, although an Italian landowner, resident in Cyprus, has destroyed vast numbers by placing in their path, soon after they are hatched and still unprovided with wings, pits so prepared that, after tumbling in, it was impossible for them to get out. This, however, is only feasible during the wingless stage, when the young locusts march across the country in great columns, more than a mile in breadth. But the most radical treatment is that of destroying the eggs, which, fortunately, are deposited, not single, but in masses in one place, generally on an uncultivated hill-side. The female inserts the eggs by means of a sword-like appendage, and sheds a glutinous matter for their protection; and, as traces of this may be seen glistening on the surface of the soil, it affords an easy clue for the searcher to discover their whereabouts. In Cyprus, rewards have been offered and taxes imposed with a view to stimulating the peasantry to destroying the eggs, 62 tons of which were brought in during 1868, representing 50,000,000,000 locusts, the result being that the pest disappeared for several years. Enormous as is the destruction caused by the locust, there is one advantage about it—viz., that it is edible, in Arabia men and horses using it regularly as an article of diet. By some of the natives they are eaten with oil after being stripped of their legs and wings, but Lady Anne Blunt, in her travels, was in the habit of boiling them, and dipping them in salt. Their flavour is described as savouring of a vegetable, not unlike the taste of green wheat.

Journal of the Society of Arts.

No. 1,603. Vol. XXXII.

FRIDAY, AUGUST 10, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXAMINATIONS, 1884.

The Programme for 1884 is now ready. Copies can be obtained gratis on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

SOLID AND LIQUID ILLUMINATING AGENTS.

By Leopold Field, F.C.S.

Lecture V.—Monday, February 26th, 1883.

Quitting the consideration of those substances which are yielded to us by the perennially renewed productiveness of the modern earth, we come to a class of luminants which may be considered as treasures from the catacombs of the dead world—from the storehouses of the young sun's heat, garnered in a newly verdant vegetation. You will recollect that, in the first lecture, I drew your attention to a great class of bodies which are now included under the common designation of paraffins, and which include such familar substances as naphtha, bitumen, asphalte, petroleum, benzene, and paraffin proper. Of the origin of these substances science affords us such ambiguous teaching, that it remains still open to anyone furnished with certain data to form his own theory on the subject. I have told you that marsh gas is a concomitant of slow organic decomposition, especially of vegetals. Now, as in the vicinity of all great sources of mineral luminants gaseous jets are of very common occurrence, it is not unreasonable to suppose that once living organisms are the primary sources of the paraffins. Yet it will not do to adopt this theory too readily, as certain warrantable men have hazarded their opinions in a contrary direction. For instance, Berthelot—than whom none have a better right to speak—suggests the following hypothesis. Acting on the supposition that Daubrée's theory of the presence of free alkalies in the earth's interior is correct, he presumes that the carbonic acid with which the earth is impregnated comes into contact with metallic sodium, forming acetylides. Steam, acting on these, would generate acetylene, and, under the circumstances of extreme heat and pressure, we might well presume that bituminous products could be aggregated, as we know that hydrogen acting upon acetylene produces olefiant gas, or ethylene. Thus we might presume that paraffins have been formed by purely mineral combinations, especially as we know that the reactions presumed to have there taken place can be exhibited with tolerable ease on the lecture table. We also know that hydrocarbons have a great tendency to molecular condensation. But the objection to this (and it is a very serious one) is, that the conditions of such extreme subterraneous heat and pressure can only obtain far below the strata in which the last vestiges of petroleum are found. We must, I think, conform to the organic theory, and grant further that the sources of petroleum are various of their kind. For instance, Illinois limestone is found to be composed of corals, in each cell of which a small particle of oil is hermetically sealed up, for which it is impossible to account, otherwise than by supposing it to be the result of the decomposition of the animalcule under the pressure of its own gases. Professor Peckham believes petroleum to be the primary product of decomposition of animal and vegetal organisms, and that the viscid and solid compounds, as bitumen and asphalte, are the results of inspissation. In Ritchie County, West Virginia, a vertical seam of asphalte cuts a horizontal coal seam in yellow sandstone, which is supposed to be the solidified distillate of petroleum wells below, especially as oil and gas springs abound in the neighbourhood. Petroleum is also found in the West of Canada, where

there are no coal measures at all; this invalidates the theory of petroleum being always the product of distillation of coal by subterraneous heat, although, as we shall see afterwards, there are good grounds for supposing this to be probable in some cases. Petroleum exists in strata of all ages, from the lowest Silurian to the Tertiary. It has even been found in the Laurentian, which was supposed to be destitute of organisms until the discovery of the eozöon. In fossil shells it is frequently found. Orthocerata sometimes hold several ounces. In Western Pennsylvania, oil is found *below* the coal strata. In the Niagara limestone of Ohio, petroleum occurs, thick and tarry, in the cavities of shells. Ohio slate contains bitumen in thin plates, and oil springs are found in the bottom layers of sandstone overlying slate. As the animal remains in slate are too few to account for the quantity of bitumen found, we must suppose that in this case it is the product of decomposition of seaweed spores and drift. That tarry matter is sometimes considerably present in slate is evident, from the fact that the piers of the suspension bridge at Cincinnati, which are made of slate, drip with oil when the sun plays upon them. From these instances given of the heterogeneous sources of petroleum, you may judge how difficult it is to form any theory of formation which shall embrace all conditions in its hypotheses. It is generally conceded that the formation of coal is based on a different action, petroleum never having been found under such circumstances as to leave no doubt of its derivation from the decomposition of wood. The chemistry of petroleum is obscure, for we cannot tell what its composition is before distilling; and yet, on the other hand, it is impossible to arrive at any ideas concerning its constitution without having recourse to that process. The composition of petroleum varies considerably, which points to the varied nature of its sources. For instance, in rocks of the Tertiary age, which contain fossil remains of complex organisms, we find a petroleum rich in nitrogen, and of putrescent odour, as the petroleum from Miocene Coast Range, South California. Further, petroleum, found in such rocks as contain low organisms, is almost devoid of nitrogen.

One noteworthy fact must not be overlooked; that the incline of the various strata has much to do with the way in which petroleum is accumulated. It may be stated, as a general rule, that petroleum wells are only to be found at the bottom of inclined strata. Thus, in Canada, where the layers are horizontal, very little petroleum is found; whereas in Pennsylvania and Ohio, the oil-bearing rocks, which are just below the surface in Canada, dip beneath the Devonian and Silurian, which furnish reservoirs for the oil condensing above and percolating downwards. In this case, the petroleum may be presumed to be the product of subterranean distillation; in proof of which may be adduced the vast evolution of gas at such places.

In its natural condition, petroleum, as you see here [this being a sample, as drawn from a Pennsylvanian well], is too dark and impure for any regular employment. To those circumstances, no doubt, it is due that the great uses of this wonderful oil remained so long unknown. The aborigines in North America knew it under the name of Seneca oil. They used it with pigments to paint their skins, and also in their religious rites, which circumstance is mentioned by the commander of Fort Duquesne, in 1750. Seneca oil was sold largely as a medicine, being, no doubt, exceeding efficacious in cutaneous disorders. Later on, we find the Dutch druggists vending "Haarlem oil," also a petroleum. The gaseous form was used first to evaporate sea-water for salt. This was done nearly 40 years ago at Malta, Morgan County.

I will dismiss the gaseous petroleums with a few brief remarks, as they have not much to do with illuminating. The principal gas wells are in Butler County, and the two largest wells are the Burns and Delameter. The latter well is at very high presure. The tube is $5\frac{5}{8}$ inches in the bore, and the gas issues from this at a pressure of 100 lbs. to the square inch. It drives a huge engine, and the gas issuing from the escape pipe, lighted, gives a flame nearly forty feet high. After being conveyed through 28 miles of pipe (6-in.) to Pittsburg, it is yet at sufficient pressure to drive powerful machinery. For twelve years gas has been furnished with undiminished vigour. The amount of gas evolved may be roughly taken as 1,000,000 cubic feet per hour, which is equivalent to 3,000 tons daily. Its light is equal to that of seven and a-half candles, and it gives, weight by weight, 25 per cent. more than bitumen. Its composition averages 82 per cent. marsh gas, 10 per cent. ethylene, and $7\frac{1}{2}$ per cent. hydrogen, with traces of various other gases.

The history of the discovery of petroleum in quantity, and of the rise of the industry, is very interesting. The first notice of petro-

eum, as an illuminating agent, was given by Dr. Hildreth, in 1819. He alludes to it as being burnt in workshops and factories. Thirty-five years elapsed since his writing before the Pennsylvania Rock Oil Company was formed, in 1854, for the purpose of gathering oil in Oil Creek, Pensylvania. Their process of collecting was a slow one, inasmuch as it consisted in drawing cloths over the surface of the naphthalised ground, which were squeezed into tubs. But in 1858, Colonel Drake, the superintendent of that company, conceived the idea of boring for petroleum, after the manner of an artesian well. Disregarding the ridicule which naturally fell to his share, his hopes were realised in August, 1859, and he began to pump oil at the rate of 400 gallons a day. The excitement was tremendous. Land in the vicinity increased a thousandfold in value, and "derricks" sprang up like mushrooms. Well after well was opened, and a corresponding number of fortunes made. But this enormous supply soon surfeited the market, as the condition of the petroleum had not been perfected sufficiently to create an adequate demand. In 1861, the price had sunk to 25 cents per barrel; whereas before it had realised 55 cents per gallon. The rapidity with which the production took place was such that, in 1860, the quantity was 50,000 barrels; in 1865, 2,500,000; and in 1873, nearly 10,000,000 barrels. At present, the oil region of Pennsylvania covers 400 square miles, on which are established 3,000 working mills. If you will refer to what I said about the inclination of strata being requisite for the formation of oil wells, you will understand that, as a matter of course, the best wells lie deepest, and a large amount of very solid slate rock and sand has to be penetrated before "striking oil." The first step in prospecting is the driving of iron pipes, six inches in diameter, into the earth with a ram, until the solid rock is reached. This has to be bored through, and is, perhaps, one hundred feet thick, usually slate. Then comes a layer of sand, which is rapidly traversed; then another layer of rock, and so through, sometimes, four or five alternations of sand and slate, until a depth of five hundred feet is reached, although occasionally the oil lies much nearer the surface. The tube is then secured, and the oil pumped. Few oil companies put down their wells themselves now, as this forms a separate branch of labour. Organised companies exist, who contract to bore at so much per foot. The average depth is about two hundred feet. A great desideratum of the oil-seeker is to find a flowing well, which, next to gas-wells, are the most astonishing phenomena of this remarkable industry. The first flowing well struck was on the farm of a man named Funk, and is known as the Funk well. In June, 1861, the boring commenced, but no sooner had the pipe touched the oil, than it commenced flowing in great volume at the rate of 250 barrels a day. In spite of all prophecies as to its speedy cessation, the Funk well flowed fifteen months, and the lucky owner cleared his "pile." Meanwhile, on a neighbouring farm, the "Phillips" well had burst forth, yielding over 2,000 barrels, daily. Thereupon the "Empire" well commenced spouting at the portentous rate of 4,000 barrels per diem. This was rather a surfeit of riches, inasmuch as no possible demand could be expected to secure so vast a supply; and the oil, when once it commenced to flow, could by no possibility be stopped. The price fell to 20 cents per barrel; then 15 cents; then 10 cents; at last the barrel itself was of greater value than the oil, and could not be procured. Finally, all the coopers in the country could not supply barrels at the rate the oil was produced; in vain they dammed it; the oil overflowed the creek, and covered the water for miles with a nauseous film. At length, by building enormous tanks, they stored the oil until the market should recover from its surfeit. For nearly a year this enormous supply continued. There are some flowing wells which do not give a continuous yield. Some cease for an hour, some for a week, and others even for several months, then continue at their usual rate. By the perfection of apparatus for its refinement and consumption, supply and demand have equilibrised, and the petroleum industry is now as standard as that of any other mineral. The average total yield of crude oil is now 75,000 barrels per diem from over 18,000 wells. The number of barrels of refined oil exported last year from New York was 6,614, 865, at a price of from $6\frac{3}{4}$ cents to $8\frac{3}{4}$ cents per gallon.

Petroleum, as it flows from the pump, is valueless for any save the crudest purposes, being a mixture of solid paraffins and heavy oils with others almost gaseous. To render it useful, it has to be distilled. The process of purification so closely resembles that employed in the treatment of the oil from shale, that one description will suffice for both, and will follow in due course. I will here give the

different products of petroleum in their order, as they differ somewhat from those of shale oil:—

	Specific gravity.	Boiling point.	Use.
Cymogen (butane)	·578-·603	0·° C	Refrigerating.
Rhigolene	·603-·629	18·°	Anæsthesia.
Gasolene	·629-·673	—	Naphthalising gas, and in air gas.
Naphtha	·673-·723	—	As a solvent, also in oilcloths, &c., street lamps.
Benzine	·723-·744	—	As a solvent, and in paints, &c.
Kerosene	·744-·838	—	Lamp oil.
Paraffin oil	·838-·906	—	Lubricating.

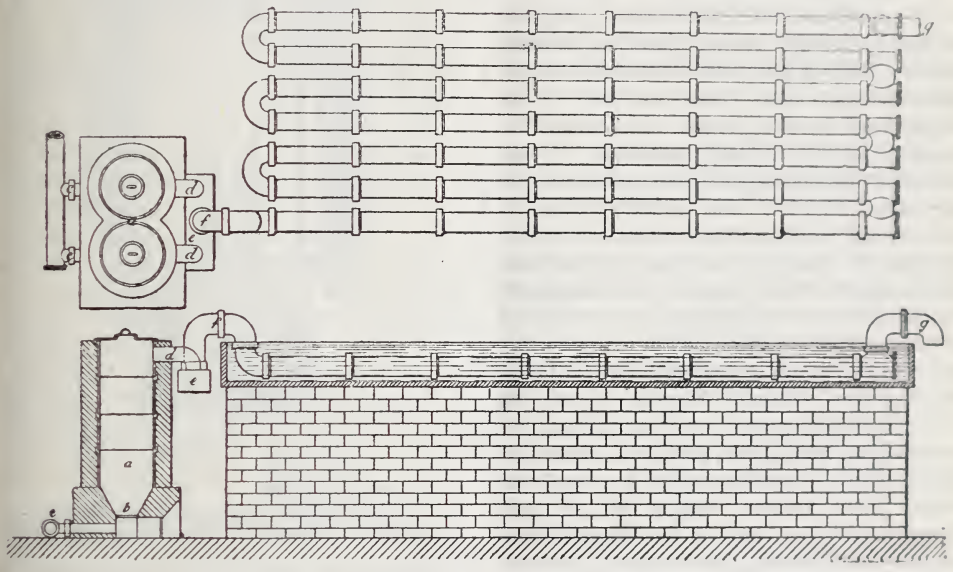
The products then grow viscid, and it is from these that the substance called "vaseline" is made.

Owing to the great danger of burning in lamps such petroleum as has not been freed from the lighter hydrocarbons (as only too emphatically attested by many mournful accidents), the testing of petroleum oil has become a Government office, and much labour and research have been spent in devising the best means for ascertaining the precise point at which the oil "flashes." By flashing point, we understand the degree of temperature at which an inflammable vapour is given off; and, however heavy the bulk of the oil may be, if it contain any proportion, however small, of the lighter oil, it will ignite at the flashing point of the latter. There are two chief systems of testing: the one being known as the open test, which, from its simplicity, was much affected in the mining districts. I have here some petroleum in a tin vessel, which I place in this beaker of hot water, wherein is a thermometer. Passing this taper over the surface of the oil, I observe a blue flash—in fact, you see the petroleum has taken fire, and is blazing furiously. I pour a few drops of the blazing oil in water, and you will notice that, instead of extinguishing it, this process animates the flame. But this method is far too rough and ready, and contains too many sources of error, to be adopted where such vital interests are at stake. Without entering into the reasons which have led our Government to adopt the instrument devised by Sir Frederick Abel for the accurate determination of the flashing point of light oils, I will give you a brief explanation of the apparatus itself, as you see it on the table. Its main objects are, to secure an uniform rate of heat and light, freedom from all air currents, and absolutely equal and constant conditions of testing. This copper vessel, six inches in diameter and six inches deep, surrounded by an air chamber, is full of water, which is heated by a spirit lamp below. The receptacle for the oil is two inches in diameter, and fits into the lid of the outer vessel, being immersed in the water to the depth of one and a-half inches. This is also surrounded by an air chamber, which conveys the heat from the water to the oil at a slow and uniform rate. The thermometer, with its bulb in the water, is fixed on the lid of the water vessel, and another thermometer enters the oil. Before commencing the experiment, the water is heated to 130° Fahr. precisely; after which the increase in temperature from the lamp proceeds at the uniform rate of two degrees per minute. The lid of the oil cover is a tiny lamp, the flame of which, being no larger than a pea, can hardly be visible to you at this distance. By a sliding inclined plane, the nozzle of this lamp is lowered into the oil receptacle simultaneously with the withdrawal of the slide, while the proportion of air in the chamber is kept constant by this little hole in the side, which opens and shuts concurrently with that in the top. Every time an opening and shutting takes place, a mixture of oil vapour and air comes into contact with the flame. The time during which the slide is opened is determined exactly by the beats of a pendulum. At a certain point, a blue flash fills the interior of the oil cup, and the temperature of the thermometer denotes the flashing point of the oil. According to the open test, the flashing point decreed as the standard of safety by the Act of 1871, was 100° Fahr., but Sir Frederick Abel, after a careful investigation of the conduct of oil which had been tested under those regulations, showed that, with his close test, the flashing point was 27° below that obtained by even the most careful open test. He, therefore, recommended 73° as the standard of safety with his apparatus, and this has been adopted by the Government. What I have said of petroleum refers also in a great measure to paraffin oil; indeed, the similitude between these two sources is very considerable; the difference lying mainly in the relative proportion of olefins and paraffins which they contain.

At this juncture we will quit petroleum for paraffin, and apply ourselves to a cursory study of this important industry. I mentioned Reichenbach as having obtained paraffin, in 1830, from wood tar. Dr. Christison, of Edinburgh, however, extracted the same substance

from Rangoon tar almost simultaneously and independently. In 1835, Dumas, the great French chemist, obtained the wax from coal tar, but it did not rise beyond the status of a chemical curiosity until 1850. In fact, in that year, Professor Abel sent my father, then vice-consul in Chili, a little specimen of a few grains in a tube, as one of the curiosities of the day. To Dr. James Young belongs the honour of creating the paraffin industry. In 1848, his attention was called by Dr. Lyon Playfair to the presence of petroleum on the top of a coal seam at Alfreton, in Derbyshire. Mr. Young at once started his operations, and succeeded in extracting a considerable quantity of paraffin, a light burning oil, and a heavy lubricating grease. This supply soon drying up, he sought other fields for his enterprise. He theorised that the petroleum had been formed by the action of heat upon the coal, and that the vapour, passing through the sandstone, had become condensed into liquid. Whether his theory was right or wrong does not matter; his results were eminently satisfactory. In 1850, he took out his celebrated patent, which, simple though its provisions were, defied all attempts at infringement, which were numerous. You are aware that,

FIG. 1.



REECE'S APPARATUS FOR DISTILLING PEAT.

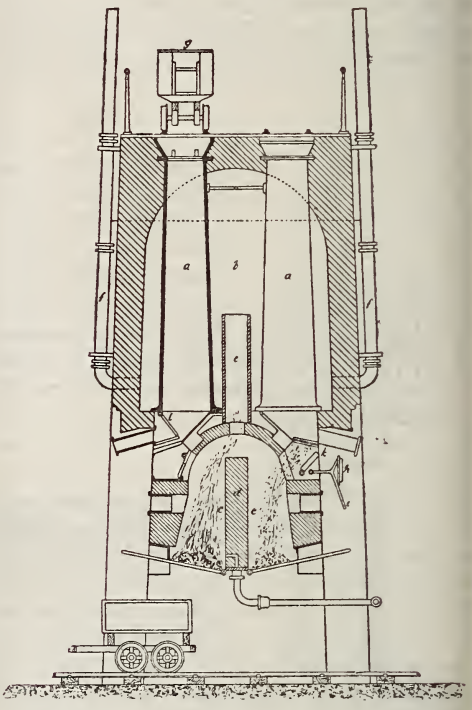
a, blast furnace, lined at top with cast iron. *b*, firebars. *c*, blastpipe. *d*, pipe leading from top of furnace, dipping under water in closed trough. *e*, from which pipe *f* leads the purified vapours into condensing apparatus *g*. The upper figure shows plan, with two retorts, as recommended in the sp. gr.

if heat be applied strongly and suddenly to coal, nearly all the volatile portion comes over as gas, the residue being tar, from which again a great number of remarkable and valuable substances, such as benzol, anilin, anthracene, and phenol are obtained. But Young discovered that, by increasing the temperature gradually, and never allowing it to rise above 600° Fahr., a thick oil distils over, which yields paraffin wax and burning and lubricating oils. I must, however, mention the invention of Rees Reece, which immediately preceded that of Young, and referred to treating peat. He first of all distils the peat tolerably rapidly in an apparatus, as shown in the diagram (Fig. 1). The tar thus obtained he distils at as low a temperature as possible, collecting half the products in one vessel, and distilling over the remainder into a second receiver. In this second distillate he finds paraffin crystals and paraffin liquid. The crystals are separated by filtration through hair-sieves and pressure, after the manner of stearin. The paraffin thus obtained is distilled, moulded, and hot-pressed. I have on the table some magnificent specimens of every step of this process, kindly lent me by Professor Bloxam, of King's College. You

see here the peat, which may be considered as the first step in the formation of coal. Here is lignite, or brown coal, extensively used in Germany. This dark thick mass is the first running; this bottle contains the lighter hydrocarbons; this light brown crystalline semi-solid is a mixture of paraffin crystals and oil, and these again are the several refinements of the wax, and the burning and lubricating oils. But the yield from peat is not to be compared with that from shale, which was the substance ultimately fixed upon by Dr. Young as the basis of his process. The first material he used on a large scale was the celebrated Bog-head coal, or Torbane-hill mineral. This valuable substance contained 70 per cent. of volatile matter, of which the major proportion was hydrocarbon. A very interesting lawsuit, in 1853, had as its issue whether Torbane Hill mineral could justly be considered as coal. Now, as Mr. Young claims coal in his patent, its validity depended upon this delicate question. It was ultimately decided against Mr. Gillespie, who had raised it. But this mineral had but a short though brilliant career, and, since 1862, paraffin oil owns as its only source bituminous shale, which abounds in Linlithgow and Midlothian. At present, the amount of this appears inexhaustible, which compensates, to a certain extent, its poverty compared with the Bog-head mineral. Between twenty-two and thirty-eight gallons of crude oil per ton are obtained from shale, which is about one-fourth of the quantity yielded by Bog-head coal. The enormous supply of oil from America, however, causes the English companies to strain every nerve to meet the competition. They are at a considerable disadvantage to start with, inasmuch as petroleum flows from the soil in the same state of purity as the shale oil attains after having undergone distillation.

I will now give a sketch of the method at present employed in obtaining paraffin oil from shale. The earliest form of retort, still largely used, is a round or oval cylinder, furnished with a hopper on top. The dimensions are about two feet in diameter by nine feet high. The retort is charged by means of the hopper, and at the bottom it opens into a trough of water, which acts as a luting. The vapours leave the retort at the top, and a current of steam enters the bottom. We will, however, discuss the process as conducted in the Henderson retort. Of this I have a diagram (Fig. 2). Each chamber contains a set of four retorts 15 feet long, capable of holding 18 cwt. of shale. A platform on the top is provided with rails, on which trollies run to and fro, charged with the shale, which they empty into the retorts. The great advantage of this form of apparatus is the manner in which the shale, by being discharged into the furnace below, is made, by the combustion of the residual carbon, to continue the distillation of the fresh material. The combustion-chamber below receives the spent shale, which is admitted by a trap. The combustion, at first sluggish, is assisted by the admission of the incondensable gases produced in distillation. In order to produce an equable temperature throughout, the flame is never allowed to touch the retorts. The heated gas alone enters the oven in which the retorts are placed,

FIG. 2.



HENDERSON'S RETORT FOR DISTILLATION OF SHALE.

a, retorts, oval in section; *b*, arched firebrick chamber, containing four retorts; *c*, furnace; *d*, dividing wall; *e*, flue, the base of which serves as screen to retorts; *f*, exit pipes for combustion products from furnace; *g*, trolly on rails, to convey shale to retort-mouth; *h i*, moveable door for bottom of retort, admitting spent shale into furnace; *k* shoot-valve, folding back into furnace arch; *l*, inlet for light gases from distillation, to be consumed as fuel; *m*, pipes for egress of vapours from retorts.

by means of the flue. By this arrangement, the whole of the apparatus is maintained at a temperature of about 800° Fahr, as against 1,200° or 1,500° in the old retorts. The products of distillation by the two methods, as you see by these two samples, differ considerably in appearance. The new process yields an oil of a bright green colour of about ·870° sp. gr., against this dark pitchy oil of nearly ·890° from the old retorts. The new process gives also 2½ per cent. less refuse, and about 2 per cent. more paraffin.* The amount of sulphate of ammonia produced is also very much larger by the new process, owing, no doubt, to the superheated steam employed. This product, at first almost disregarded, is now one of the pivots on which the success or failure of a factory turns. After leaving the retort, the vapour passes through a series of upright pipes fitted into a trough, after the manner employed in the distillation of palm oil (see Fig. 2 in Lecture IV.); by this means about one-third of the vapours are condensed, the products consisting mainly of ammoniacal liquor, with about 25 per cent. crude oil. The uncondensed portion passes through a tower over which paraffin oil trickles, which takes up a very great proportion of the light vapours. The crude oil, after separating from the ammoniacal liquors, is pumped into a still, and brought to dryness in a current of superheated steam. After passing through a system of condensers, the liquid, which has now assumed a brighter green tint, is received into a suitable vessel. In the retort there remains a very fine pure coke. The oil is next freed from water, and then, by violent agitation with strong sulphuric acid, from the tarry impurities. After two or three such agitations, and subsequent separation of sediment, the oil is treated with a solution of caustic soda, to neutralise the acid, and then with a little warm water, which washes out the residual soda. The amount of acid and soda used depends considerably on the nature of the oil. The effect of this process on the distillate is to reduce its gravity to between ·830 and ·845, it having lost about 15 per cent. in the process of refinement. It is now subjected to fractional distillation. I have here a small apparatus which will, perhaps, explain the process better than words can do to those who are unacquainted with the operation. In this retort there is a mixture of various light and heavy oils. A thermometer is passed through the tube of the retort, which is connected with a glass condenser. As long as any oil of lighter boiling point than the others remains undistilled, the temperature will not rise beyond the boiling point of that oil. While, therefore, the thermometer remains constant, the products of distillation may be presumed to be of one kind. As soon as the light oil is exhausted, the temperature rises until the boiling point of the next lightest oil is reached, after which it will remain constant until the whole of that is distilled, and so on, until the distillation is finished. Upon this convenient property the distillation of paraffin oils is based. The first distillate, which is exceedingly light, is set apart for naphtha. Oils of sp. gr. ranging from 770° to 850° are reserved for burning; and distillation is then continued till the liquid in the still has reached a depth of between 12 and 18 inches. The last fraction is very heavy, and contains nearly 30 per cent. of paraffin. The burning oil is purified with repeated washes of acid and soda, and again distilled. The distillate is similarly treated—this time with less acid—and it is then distilled again, the fractions being carefully separated. The specimens on the table will show you the different fractions and their employments. The distillate from ·760° to ·790° is "No. 2 burning oil;" from ·790° to ·806° "No. 1 burning oil;" ·806° to ·820° "lighthouse oil;" while the fractions from 825° to 840° are mixed respectively with No. 1 and No. 2. Various purifications have still to be undergone by No. 1 oil before it assumes the beautiful limpidity which gives it the name of "crystal" oil. The liquid from the coke tower is mixed with the first distillate from the purified oil, heated with acid and soda, and distilled. The runnings from 640° to 660° are set aside as gasoline; from 700° to 720° they are termed naphtha. The names of the various fractional oils from petroleum and shale oil are much the same. I will refer you, therefore, to what was said under the former head for the names. In the next lecture, I shall point out the difference in their chemical constitution.

We have now to consider the process of purifying the paraffin scale. The heavy oil obtained from the last stage of the first distillation, is crystallised from the oil. The hard scale is that which separates by itself in ordinary weather, and the residual oil from this is subjected to artificial refrigeration, in which process gasoline is largely employed.

* See correspondence as to respective merits of new and old systems. *Proceedings of the Institution of Civil Engineers*, vol. lxvi., part iv.

This yields the soft scale. The separation of the solid from the liquid paraffin is a point of immense importance, and no less the refinement of the solid paraffin from all traces of oil. The former object is attained by repeated refrigerations and filtrations under pressure; the latter by washing the scales repeatedly with naphtha, which keeps the oil in solution, and deposits the refined paraffin. Finally, the paraffin is agitated with very fine animal charcoal; and upon the selection of this article also much depends. Upon filtration from the charcoal the paraffin is run into circular moulds, and, when cool, presents the magnificent appearance which you see in this cake from Messrs. Young's Works. I must here express my obligations to Mr. Fyfe, the manager of that Company, for his discriminating kindness, which has provided me with such numerous and well-chosen specimens. The oil which is pressed from the soft paraffin scale is called "blue" oil, from its peculiar colour; and this, after acidification and treatment with soda, furnishes lubricating oils. The melting point of the best paraffin is about 130° F., ranging down to 100° F., below which it is unsuitable for making into candles. The above is an outline of the manufacture of paraffin, which can only be filled in by reference to the works on the subject. Indeed, I have been forestalled in this branch again by Mr. Brunton, who, a short time ago, read a most exhaustive paper on the paraffin industry before the Institution of Civil Engineers. I have reserved the account of the probable constitution of the various forms of paraffin and petroleum, and other points connected therewith, for the final lecture.

Miscellaneous.

MINING STATISTICS.

The following analysis of the official returns relating to the mineral production of the United Kingdom is taken from *The Economist*:—

From the returns, it appears that our mineral production last year was the largest on record. As will be seen from the following tables, which give the output for each of the past ten years, there was a slight diminution in 1882 of the production of ironstone, the decline being largest in the Durham district; this, however, was compensated for by an increase in the quantity of iron produced, while the production of coal exceeded that of the previous year by fully 2¼ millions of tons. The figures are:—

Minerals Wrought in Mines Classed under the Coal Mines Regulation Act.

Year.	Coal.	Ironstone.	Fireclay.	Shale, &c.	Total.
	Tons.	Tons.	Tons.	Tons.	Tons.
1882	156,499,977	11,505,447	2,209,036	1,119,573	171,334,03
1881	154,184,300	11,858,766	1,896,907	1,019,958	168,959,94
1880	146,969,409	11,664,726	1,938,539	894,119	161,466,79
1879	133,720,393	9,387,766	1,455,003	803,207	145,366,36
1878	132,612,063	10,747,227	1,625,586	813,262	145,798,13
1877	134,179,968	12,014,356	1,813,541	838,395	148,846,26
1876	134,125,166	12,159,580	2,071,983	632,656	148,989,38
1875	133,305,485	12,018,594	1,932,294	442,910	147,700,31
1874	126,590,108	11,693,186	2,067,791	362,747	140,713,81
1873	128,680,131	12,094,827	1,742,193	524,095	143,041,24

Quantities of Principal Minerals Raised in Mines Classed under the Metalliferous Mines Regulation Acts.

Year.	Iron ore.	Copper ore.	Lead ore (Dressed).	Tin ore.	Zinc ore.
	Tons.	Tons.	Tons.	Tons.	Tons.
1882...	3,596,747	52,135	63,605	12,157	31,267
1881...	3,244,657	52,583	63,445	11,788	34,134
1880...	3,140,269	51,546	68,547	12,327	26,898
1879...	2,483,979	48,738	65,596	13,389	20,887
1878...	2,559,333	54,568	74,771	14,220	24,682
1877...	2,815,848	65,269	76,471	13,341	24,227
1876...	2,637,546	71,741	73,465	12,637	23,670
1875...	2,673,899	66,214	70,613	12,611	22,342
1874...	2,468,732	72,711	69,545	13,162	18,425
1873...	2,715,574	80,256	71,315	14,095	13,545

In the metalliferous mines the number of persons employed last year was 55,506, the average for the previous nine years being 54,507, and in these mines the changes, both in the amount of production and in the number of persons employed, have been comparatively small. It is different, however, with the coal mines. The number of those in operation had decreased from 4,501 in 1875, to 3,814 last year. But although fewer mines were being worked, larger quantities of minerals were obtained from those in operation, with the result that while in 1875, when the larger number of mines were working, the total product was 147,700,000 tons, it amounted last year to 171,334,000 tons. It is noteworthy, too, that the larger output of 1882 was raised by a less number of persons than in the smaller production of 1875, the number of persons employed in 1875 being 535,845 and in 1882, 503,987.

From the great increase in the output per head which has risen from 278 tons in 1873, to 340 tons in 1882, it is evident that our mines are now much more efficiently worked than they were at the beginning of the decade, and for this three reasons may be

assigned. In the first place, the least productive mines have ceased to be worked, because while it was possible to work them at a profit during such years of exceptionally high prices as 1873 and 1874, their working would be unremunerative at present prices. Labour is now concentrated on the mines where it can produce the best results, and its efficiency has therefore been augumented. Secondly, the labour is now more energetic than it was ten years ago. Then the miners were demoralised by exceptional prosperity. They were earning very high wages, and they chose to take the advantage of this to work both fewer hours and less hard than they did before, and now find it necessary again to do. And, thirdly, the labour is not only more energetic, but it is also of better quality. In order to cope with the greatly increased demand for coal and iron, which was experienced in 1873, large numbers of persons were then employed in the mines who had no previous experience of, or training in, that kind of work. Now, however, this unskilled labour has been weeded out, and the proportionate efficiency of what remains is increased. Besides, as will be seen from the following comparative statement, the number of females and children now employed is much smaller than it was two years ago :—

AGE AND SEX OF PERSONS EMPLOYED.

	1882.	1873.
Under Ground—		
Males, 10 to 12	380	1,202
,, 12 to 13	3,584	11,309
,, 13 to 16	36,914	45,931
,, Above 16 ..	365,314	349,366
Above Ground—		
Females, 10 to 13 ..	1	31
,, 13 to 16 ..	307	790
,, Above 16..	4,344	5,383
Males, 10 to 13	491	2,070
,, 13 to 16	8,066	6,957
,, Above 16 ..	84,586	91,110
Total.....	503,987	514,149

	1882.	1873.
Proportion of underground workers above 16 to total	90 ..	85½
Propertion of underground workers below	80·1 ..	79·3

The proportion of males above 16 working underground to the total employed there, which in 1873 was 85½ per cent., had risen to 90 per cent. last year, and similarly the proportion of persons working underground to the total number employed about the mines rose from 79¼ per cent. in 1873 to 80½ per cent. last year. Thus, a considerably larger proportion of the persons working in our mines now are adults than was the case ten years ago, and a larger proportion of the whole number employed are engaged in the actual mining work.

The hope was, that the responsibilities imposed upon employers by the Employers' Liability Act would tend to diminish the loss of life attending the working of our mines. And probably it has done something in this direction. During the two years in which the Act has been in operation, however, the death-rate, though less than the average for the decade, has been high, the proportion of lives lost to the number of persons employed in the mines worked under the Coal Mines Act, and the total output in each of the past five and ten years being as follows :—

Year.	Number of lives lost.	Death-rate per 1,000 persons employed.	Quantity of minerals raised for each life lost.
			Tons.
1882	1,126	2·234	152,1[illegible]
1881.....	954	1·925	177,1[illegible]
1880.....	1,318	2·718	122,509
1879.....	973	2·040	149,400
1878.....	1,413	2·972	103,1[illegible]
1877.....	1,208	2·443	123,21[illegible]
1876.	933	1·813	159,68[illegible]
1875.....	1,244	2·521	118,73[illegible]
1874.....	1,056	1·959	133,251
1873.....	1,069	2·079	133,67[illegible]

It is to be feared that a considerable portion of this heavy mortality is due to the carelessness of the men themselves, and against this carelessness it is peculiarly difficult to guard. It is the opinion of some of the inspectors, too, that the provision which has been made for the workmen, in the event of an accident, has tended to make the miners somewhat less careful than before. Thus Mr. Dickinson states that, "it is supposed that in some cases carefulness and fear of accident are being lessened by the large contributions given by owners to accident funds, and the liberal provision made for the sufferers by accidents, and to their families in case of death." The experience of the past thirty years, however, has shown that it is possible, by the stringent enforcement of wise regulations greatly to diminish loss of life through accidents. In the ten years, 1851–60, the death-rate from accidents was 4·072 per 1,000 persons employed. In the next ten years, 1861–70, it fell to 3·328 per 1,000; and in the last decade, it further dropped to 2·353. These are encouraging results to have realised, and it is to be hoped that no efforts will be spared to ensure that the progressive amelioration shown during the past thirty years shall be made to continue.

FORESTRY.

In Committee of Supply, on Wednesday, the 2nd instant, Sir J. Lubbock took the opportunity of saying a few words on the subject of the Woods and Forests Vote, and asked her Majesty's Government

during the autumn to consider the question of forest education in this country, and whether the national forests might not be utilised for this purpose. So much, indeed, had forestry been neglected, that in Scotland the words suggested deer, but no trees; while the idea of foresters in England was associated with the members of an excellent provident institution. Of course the Crown forests formed but a small part of the subject. There were altogether, in round numbers, 2,500,000 acres of woods and plantations in this country, so that the subject was one of vast importance. Moreover, it was calculated that in Scotland and Wales there were 5,000,000 or 6,000,000 acres at present almost valueless, and which, if judiciously planted, would give large results. In the science of forests we were, he feared, far behind most foreign countries, especially France and Germany; and he was very anxious that our landed proprietors should benefit by the experience which other nations had acquired. But let him ask, where was a country gentleman who owned woodlands to obtain information as to their management, or to procure trained assistants? We had no forest school in this country; we had no class of persons specially trained and instructed in the formation and management of woods. It was, he feared, still true that, as the House of Commons' Committee of 1854 reported, timber is "everywhere worse managed than any other species of property." Unless something were done this state of things would continue. On the other hand, the highest authorities had expressed a very strong opinion that we might make our woodlands much more profitable; they showed one step which was a necessary preliminary. The highest English authorities were strongly in favour of the establishment of a forest school, and had forcibly pointed out the loss which our present system of management, or rather mismanagement, entailed on landowners. Mr. Brown, in his standard work on forests, observed that "if our forests had been judiciously managed, we should not find so great a part of the woodlands of Great Britain in the unprofitable state in which they are." We were the only important nation in Europe without a forest school, and yet, if we included our colonies, our forests were the largest and most valuable in the world. It appeared to be a very strong argument in favour of the establishment of a forest school in this country, that at present the young men who were going out to manage our Indian forests had to be sent for instructions to the great French Forest School at Nancy. No doubt that was a most excellent institution, and we were indebted to the French Government for the courtesy with which they had received our English students; but the system of education given there naturally contained some branches, as, for instance, the study of French law, that were not adapted to English students, while there were many other considerations, such as climate, which rendered a Continental school less suitable for English requirements. He might add that no young Englishmen, as a matter of fact, went there excepting those intended for the Indian service. For our colonies, again, the establishment of a good forest school here would be of very great importance. A judicious management of their woods would add considerably to their income. French foresters have recently been sent to the Cape of Good Hope and Cyprus, it having been found impossible to obtain any countrymen of our own with the necessary knowledge. Perhaps, however, he should be asked why the establishment of such a forest school, if it were so urgently needed, should not be left to private enterprise. The reason was clear. A properly equipped forest school must have attached to it a large extent of forest in various stages, and having a variety of climates and soils. This, it was obvious, no private institution could supply. He did not, however, say that this would necessarily involve the establishment of a Government school. He understood that the Government contemplated an arrangement with the Cooper's-hill College, but he trusted that, before instituting a Government school, they would inquire whether such colleges as Cirencester could be made available for the purpose, and possibly some arrangements might be devised by which, under careful regulations, the professors and students attached might periodically visit our national forests. He might mention, in illustration, that lately the Cape of Good Hope Government determined to appoint a Forest Commissioner, with an income of £800 a-year. They could not, however, find any qualified Englishman, and were obliged to appoint a French gentleman, even though he could not speak English. The Society of Arts had memorialised her Majesty's Government on the subject, and the presence in this country of Dr. Brandis and Colonel Pearson rendered the moment one of which it was desirable to take advantage. He hoped, therefore, her Majesty's Government would not think him unreasonable if he asked them to consider this important question.

AGRICULTURE IN MOZAMBIQUE.

The only agricultural industries that can be said to have firmly and successfully established themselves in the province of Mozambique, appear to be those of the cultivation of the oil-producing plants, *Amendoim* and *Gergelim*. The production of these, says Consul O'Neill, together with the collection of india-rubber, calumba root, and orchilla weed, forms five-sixths of the total exports of the province. This cultivation, and the labour requisite for the collection of the latter products mentioned, is conducted solely by the natives. Efforts have been made from time to time, by the Portuguese and other colonists, to introduce the cultivation of other produce for which both the climate and the soil are especially favourable, but none have been thoroughly successful. Of the greatest importance have been the endeavours in

various parts of the coast to raise sugar, opium, tobacco, and coffee. As the cultivation of *amendoim* and *gergelim* is entirely in the hands of the natives, it follows, as a natural consequence, that every stage of the working is of a most rude and primitive kind. The thousands of acres that are utilised in the cultivation of these seeds are cleared in great part with an axe of native make, of tomahawk shape, and with an edge hardly two inches in length. In some parts, particularly in the European settlements, a species of bill-hook is also used for clearing the undergrowth, but these two form the only tools of the Makua forest clearer. The vast area of country cleared is then turned over by both men and women with a rough and clumsy hoe, also of native make, the slow working of which entails an enormous and unnecessary consumption of labour. In the sowing of *amendoim*, holes are made in the ground some little distance apart, generally three or four feet, to allow space for the creeper to radiate. This is usually done with a sharp-pointed stick. One seed—care is taken that it is only one, as the natives declare that the growth of two or three will strangle each other—is then dropped in each hole, and the earth stamped over by the feet. In the sowing of *gergelim*, the seed is broadcast as with grain, and scattered thickly over the ground. The sowers are then followed by others with hoes, who work the seed roughly into the ground, stamping the whole in with their feet. Care and therefore much labour is required to keep the ground clear of weeds that spring up in this climate and soil with astonishing rapidity, and throughout the growth of both these plants, the plantations are carefully tended. In the reaping or collection of *amendoim*, the plants are simply pulled up by hand, and the tubers taken off as with the common potato. They are then laid out to dry in the sun, and when thoroughly dried, are shelled by hand for the extraction of the seed, an operation requiring considerable time and patience. With *gergelim* the plant is in some districts literally reaped, but singly and by hand, with an ordinary knife. In others the plants are simply pulled up out of the ground; in the latter case they are then cut about a foot down the stem. The plants are now tied into small bundles, which are stuck in the ground in the sun till thoroughly dried, when the seed will drop readily off. Large mats are then spread on the ground, the bundles taken up and shaken vigorously over them till all the seed have thus been extracted. With both *amendoim* and *gergelim* the seeds are then packed in baskets of native manufacture, and carried on the heads of the blacks, in some cases a distance of fifty or sixty miles, to the house of the coast trader, there to be bartered for cloth, beads, powder, &c., and to be stored till an opportunity occurs. The sugar cane is cultivated by the natives upon most parts of the coast where alluvial soil exists, but only in insignificant quantities, and to be used by them as a sweetmeat, or for the purpose of chewing. The only part of the province where its growth has been attempted upon any considerable scale is in the rich soil of the Zambesi delta, and by the Portugese planters of that district; numerous plantations exist there, and the cane grows luxuriously upon them. The only use, however, to which the cane has, up to the present time, been put, is that of the distillation of spirits. Consul Baring says, that beyond the Zambesi, there are many places in the province eminently adapted for the growth of the sugar cane, and which possess easily accessible and secure ports for discharge and shipment. Amongst these may be mentioned Mwambi Bay (Pomba), Mwendazi (Mwemba), the western shores of Nakaha and Nihegehe, on the branches of Fernao Veloso Bay, and the country to the south and in the vicinity of Mokambo Bay. Tobacco, though cultivated as an article of commerce for export, has not met with much success, as the passion for the weed has become deeply rooted in the natives of the coast and interior, so that it is cultivated by them in many parts of the province for their own comsumption, and forms a regular article of sale and barter amongst themselves. The tobacco leaf is dried very carelessly by the natives, and is made up in a peculiar way, as follows:—It is first plaited, and when the plait has reached a length of three or four feet, it is wound up in the form of a spiral. Gradually drying in this shape, it preserves its form without any binding, and it is unwound and cut off in short pieces when required for use or sale. This mode of preparation is invariable among the Makua and Yao, between the Roouma and Zambesi. Consul O'Neill says, that "were the natives instructed in some simple method of drying and pressing the leaf, the valuable product would be probably brought down by them in considerable quantities, affording, as it would do, a larger margin for profit than does the culture of oil seeds, and it might become a regular article of colonial manufacture and export." Among the many plants useful to commerce that grow wild on the coast land and interior of Mozambique, may be mentioned the castor-oil plant, the senna plant, a species of sarsaparilla, the capsicum, or common red pepper, used by the natives with their food, but as yet not gathered by them for sale, in spite of the efforts of some merchants to induce its collection; and the pine apple, the fibre of which has been lately proved to be a valuable substitute for flax.

THE PATENT BILL.

The Patent Bill was read a third time in the House of Commons on the 4th instant, and some small further alterations were made, in addition to those made by the Grand Committee, as stated in last week's *Journal*. Some of these were in the portion of the Bill relating to trade marks. In that devoted to patents, a new clause was inserted

to the effect that certified copies of specifications, &c., left at the Patent Office, should be transmitted to the Edinburgh Museum of Science and Art, and to the Enrolments Office of the Irish Chancery within twenty-one days from their receipt in London; and the clause relating to the use of the Royal Arms was modified so that, as it now stands, it prohibits the use of the Royal Arms, or any close imitation of them, in a way to cause the belief that any particular trade or profession was being carried on under the authority of the Royal Family or the Government.

The Bill was then sent up to the House of Lords, where it was read a first time on Monday, the 6th instant. It was down for reading a second time yesterday (Thursday).

Under these circumstances there can be little further doubt as to the Bill becoming law this Session.

Correspondence.

EARLIER HARVESTS, AND CHANGE OF SEEDS.

In the present complaint of "want of sunshine," two things must be kept in view, the ripening of our crops for food, and the maturing of seed-corn for future use.

A few words on each, if you please.

We have no defence against inclement weather when it comes, yet we might perhaps anticipate it by trying for earlier harvests. In northern countries, grain is sown and reaped more quickly than amongst us. There are differences of climate and of soil, yet why should we not import, for a term, the seeds of Norway and Sweden? Professor Schübler, of Christiania, asserts, as the results of lengthened experiments, that seeds retain for several seasons, on southern soils, the powers they manifested on northern soils; also, that one effect of changing soil is, with seeds, the putting forth of fresh powers. Change of conditions seem to call into exercise latent forces. For accounts of the rapidity and the certainty of germination in Swedish soils, allow me to refer inquirers to the catalogue and pamphlet combined, by L. J. Wahlstedt, Commissioner from Sweden at the Exhibition in Amsterdam.* Let me add, also, that (see page 15) "Mr. L. O. Smith, a merchant of Stockholm, has generously placed at the disposal of the Swedish Royal Academy of Agriculture, a considerable sum of money, to be applied to sending into different parts of Southern Europe grains of cereals as well as of other seeds, for the purpose of instituting comparative tests between Swedish seeds and those produced in southern lands."

What consequences would ensue from the use of Swedish cereals for seed in our soil, can only be learned by experiment; but it is certain that harvest towards the end of summer is less likely to be interrupted by bad weather than harvest in autumn, a fortnight or three weeks later. Early crops, too, command higher prices.

Though we cannot protect ourselves against ungenial weather, we may take precautions against defective seeds. These are not likely to be very common in a country of which Mr. McCulloch said, so long ago as 1871:—"Notwithstanding the general inferiority of the soil, and the backwardness of the climate, agriculture has within the last twenty years made a more rapid progress in Sweden than in perhaps any other country in Europe; instead of importing, as was formerly the case, she now exports large quantities of oats and other grain."—(*Dictionary of Commerce*, new ed.: art. Stockholm.)

For a long time we drew our supplies of larch and fir seedlings from Scotland, now they come largely from Sweden. Why should we not try the cereals also? In the catalogue above-named, besides the address of the Society, or the individual exhibiting, may be found the common and the botanical names of thirteen hundred different samples of seeds, suitable for agriculture or horticulture. The weight in grammes is given of one thousand grains or seed-corns of each sort, also its standard of purity—that is, its freedom from weeds; lastly, its growing power (*pouvoir germinatif*).† At the depôt in Amsterdam these seeds are shown in bottles, stoppered and sealed; on every one is a descriptive label, for the accuracy of which the honour of many representative bodies is a guarantee. Such precautions are unusual and very valuable. An intending purchaser need only describe the soil he cultivates, to be certain of securing sound if not suitable seed.

Owing to the action of the Royal Academy of Agriculture, in 1874, several stations of control were established in Sweden for the growth and diffusion of seeds. Sixteen are now distributed over the country. Since then, "*fröodlareföreningar*" have attended to the preparation and circulation of manuals, of machinery too for cleaning seeds, and special exhibitions have been periodically held. In 1880, there was one at Christianstadt; in 1881, at Boras; in 1882, at Sundsvall; for 1883, one is announced at Kalmar.

The causes of the superiority claimed for Swedish seeds are too numerous for me to enter upon. It is, perhaps, enough to say that the labours of Linnæus have not been lost among his fellow-countrymen.

JOHN YEATS.

Chepstow, August 7th.

* No English translation of this pamphlet (which is in French) has yet appeared.

† By this is meant the per-centage of seeds that strike root in a definite period. For cereals it is seventy-two hours. See catalogue, p. 8.

Journal of the Society of Arts.

No. 1,604. Vol. XXXII.

FRIDAY, AUGUST 17, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXAMINATIONS, 1884.

The Programme for 1884 is now ready. Copies can be obtained gratis on application to the Secretary.

SWINEY PRIZE.

The Council have to give notice that the next award of the Swiney prize will be in January next. Dr. Swiney died in 1844, and in his will he left the sum of £5,000 Consols to the Society of Arts, for the purpose of presenting a prize, every fifth anniversary of the testator's death, to the author of the best published work on Jurisprudence. The prize is a cup value £100, and money to the same amount; the award is made jointly by the Society of Arts and the College of Physicians. The cup now given is made after a design specially prepared in 1849 for the first award, by D. Maclise, R.A. Any person desiring to submit a work in competition, or to recommend any work for the consideration of the judges, should do so by letter addressed to the Secretary of the Society.

The following is a list of recipients:—

1849. J. A. Paris, M.D., and J. Fonblanque, for their work, "Medical Jurisprudence."
1854. Leone Levi, for his work on "The Commercial Law of the World."
1859. Dr. Alfred Swayne Taylor, F.R.S., for his work on "Medical Jurisprudence."
1864. Henry Summer Maine (now K.C.B.), D.C.L., member of the Legislative Council of India, for his work on "Ancient Law."
1869. William Augustus Guy, M.D., for his "Principles of Forensic Medicine."
1874. The Right Hon. Sir Robert Joseph Phillimore, D.C.L., for his "Commentaries on International Law."
1879. Dr. Norman Chevers, for his "Manual of Medical Jurisprudence for India."

Proceedings of the Society.

CANTOR LECTURES.

SOLID AND LIQUID ILLUMINATING AGENTS.

By Leopold Field, F.C.S.

Lecture VI—Monday, March 5th, 1883.

It was stated in the last lecture, with regard to the formation of petroleum, that Berthelot's theory of a mineral origin could not be well entertained, inasmuch as the postulated degrees of heat and pressure could not be found at the depth at which the last traces of petroleum occur. It may be that a sudden decomposition of organic matter under heat and pressure, where the gases generated are confined in contact with the liquid products, would bring about the formation of paraffin and olefine. Of coal we know that it is formed from vegetal matter, and, to a vast extent, from drift and accumulation of spores. But this is not always a process of such infinite time as is generally supposed. Wood, bearing marks of human labour, has been found partially carbonised—witness the piles driven in by the Britons to retard Cæsar's advance, the outer surfaces of which had undergone a decided carbonisation. We are in possession, too, of all the links which connect coal and green wood. Here are specimens of peat, taken at different depths, becoming denser and denser, and, at a depth of 14 feet, resembling lignite—though less dense—and only requiring pressure to reduce it to a true coal; and here the gradations from lignite through all the coal varieties to anthracite. We may suppose that cellulose $C_6H_{10}O_5$ (wood-fibre) is split up according to the equation—

$$2C_6H_{10}O_5 = 5CH_4 + 5CO_2 + C_{10},$$

and this is well supported by the abundance of marsh gas and kindred hydrocarbons found in the vicinity of coal mines. The variation in

constitution undergone by wood-fibre, while changing to coal, is as follows:—

	Carbon.	Hydrogen.	Oxygen.
Wood	100 ..	12·18 ..	83.07
Peat	100 ..	9·85 ..	55·67
Lignite	100 ..	8·37 ..	42·42
Bituminous coal ..	100 ..	6·12 ..	21·23
Anthracite	100 ..	2·84 ..	1·74

As I observed when speaking of petroleum, we cannot well form an idea of its true constitution, inasmuch as during distillation what is termed "cracking" takes place, *i.e.*, the splitting-up of molecules, by which one equivalent of a dense hydrocarbon may yield two or more lighter members, perhaps even of different series. Certain it is that, by the rapid distillation of heavy oils at a high and sudden heat, products are obtained which could not have existed in the original substance. When paraffins are heated under pressure, both paraffins and olefines are formed—

$$C_{20}H_{32} = C_5H_{12} + C_{15}H_{30} = C_7H_{16} + C_{13}H_{26} = \text{\&c., \&c.}$$

All the known paraffins have been obtained from Pennsylvanian petroleum, and the olefines, $C_{10}H_{20} - C_{13}H_{26}$. The main difference between petroleum and shale oils lies in the amount of olefines contained, which preponderate in the shale oil, as would be supposed. A gaseous petroleum consisted of 90 per cent. CH_4, 8 per cent. C_2H_6, and 2 per cent. H; while the gaseous products of distillation of shale, analysed by Coleman, gave C_4H_8, C_5H_{10}, and C_6H_{12}, all olefines. The paraffin hexane, C_6H_{14}, a main constituent of American petroleum, is closely allied to cellulose, $C_6H_{10}O_5$.

A more detailed formulation of the change would be:—

Vegetable fibre..	$C_{12}H_{20}$	O_{10}
Peat	$C_{12}H_{14}{\cdot}_4$	O_5
Brown coal.....	$C_{12}H_{13}{\cdot}$	$O_{3}{\cdot}_8$
Lignite	$C_{12}H_{11}{\cdot}_3$	$O_{3}{\cdot}_2$
Bituminous coal .	$C_{12}H_9$	O_3
Asphalte	$C_{12}H_{7}{\cdot}_7$	$O_{1}{\cdot}_1$
Elastic bitumen .	$C_{12}H_{22}$	$O_{0}{\cdot}_{15}$
Petroleum	$C_{12}H_{24}$	

The equivalents have been doubled throughout, to avoid too small fractions.

which last would be obtained by the whole of the oxygen being evolved with half its volume of carbon as carbonic dioxide, which would leave the proportions of carbon and hydrogen as shown.

But as, wherever wood is found in process of decomposition, the elements of hydrogen and oxygen are being evolved—as H_2O and CO_2—in such proportion to the carbon as would tend to leave the latter ultimately free—as in anthracite—we must conclude that the formation of petroleum from wood, if it ever took place, must have been carried on by some unknown and extinct process.

The following table shows the chief differences between the oils obtained severally from shale, petroleum, and coal tar:—

	Shale.	Petroleum.	Coal tar.
Naphtha	70 per cent. heptylene C_7H_{14}; various paraffins, *no* benzene	70 per cent. heptane C_7H_{16}; olefines *and* benzines	Almost entirely C_6H_6 (benzene)
Photogene	50 to 80 per cent. C_nH_{2n}, remainder C_nH_{2n+2}	50 to 80 per cent. C_nH_{2n+2}, C_nH_{2n}	—
Lubricating	C_nH_{2n}, and C_nH_{2n-2}	Less C_nH_{2n}	—
Paraffin	C_nH_{2n+2}, *no* vaselene	C_nH_{2n+2}; wax (and vaselene)	—

We come now to the solid, and partly solid, or viscid forms of native bitumens, which are very numerous. Under the name of petroleum is understood now the liquid form of natural hydrocarbon, but there is little doubt that the viscid and solid forms, as asphalte, tar, and bitumen—I speak, of course, of natural products — are forms of petroleum which have undergone condensation, either before or after the destructive distillation or putrefaction, which we suppose to be the origin of petroleum. Such names as Rangoon tar, or Burmese naphtha, Barbadoes tar, Trinidad pitch, and the like, cannot be regarded as defining accurately the substances to which they are applied. It would be useless for me here to enter upon the difference in the chemical constitution of all these varieties, each of which has acquired a reputation rather due to the prolific nature of its special source than any particular merit. I will select Rangoon tar for a few moments

consideration, as it has a place in the early history of paraffin. You know that Mr. Rees Reece obtained paraffin on a large scale by destructive distillation of peat; and a small company was formed in 1850, for working that material. Although this company was unsuccessful, it was through its agency that the first paraffin candles were brought before the public. Now, in 1854, Dr. De La Rue took out a patent for purifying and working Rangoon tar, or Burmese naphtha. Price's Patent Candle Company took this up, and worked it on a very large scale. It is worthy of remark that, in 1859, they actually sent 10,000 gallons of their oil to New York, which would now, indeed, be equivalent to sending "coals to Newcastle." I do not know that paraffin was ever obtained from this material on a large scale, Dr. De La Rue's patent referring to its treatment with nitric acid, for separation of the olefines and benzenes. In 1851, medals were awarded to Young for paraffin oil from coal; to Wiseman, from shale; and to Moreau, from bitumen. At the Paris Exhibition of 1855, the works of Mont Auriol, near Paris, exhibited paraffin from resin, of which were distilled annually nearly 3,000 tons. The amount of paraffin is, however, so small as to be useless on a large scale. It must be remembered that, although I have not mentioned lubricating oil with any particular emphasis, since it is extraneous to my theme, this is at least of equal importance with the solid paraffin and the burning oil. The amount of lubricants consumed is enormous, and, from the fact of their freedom from oxidation, absence of acid properties, and general immutability, are supplanting animal and vegetal oils in all directions. A great portion of the liquid bitumens from Burmah, Rangoon, and Baku are devoted to producing lubricants. I stated, you will remember, that the attention of the Russians had been actively directed to the construction of a lamp that should burn their heavy oils, and we are told that considerable success has attended their efforts. They are reported as being able to burn oils from ·860 to ·910. The importance of this to Russia is very great, as the oil of Baku contains nearly three-fourths of its weight of such heavy oils.

Asphalte yields, on distillation, both paraffin and paraffin oil; but its chief use is, as is well known, for roadmaking. Coming now to the solid forms of natural hydrocarbon, we have the remarkable mineral, ozokerit, which, within the last ten years, has become almost a household word. The localities where earthwax, as ozokerit is often called, is found, are exceedingly few, in fact, I may say, there is only one spot where the genuine mineral has been found in any quantity, and that is in Boryslaw in Galicia. There are, no doubt, in the neighbourhood, and perhaps at intervals along the shores of the Danube, sources of ozokerit, but, though hardly a week occurs without specimens passing through my hands from nearly all parts of the globe, and all purporting to be ozokerit, I have found none which could compare for a moment with that from Boryslaw. A great number of specimens are marl or sand, caked with thick petroleum, and yielding on distillation an almost worthless oil. I have placed on the table a number of specimens of natural bitumens, from the very lightest naphtha down to the purest ozokerit. You will, I think, find that there are few countries which are unrepresented. Professor Boverton Redwood, the secretary to the Petroleum Association, has very kindly supplied me with samples of the chief kinds from the most noted sources, and the Rev. Urban Smith has contributed a collection which transcends in interest perhaps any on the table, inasmuch as it embraces specimens from Castleton in Derbyshire, the scene of Dr. Young's first discoveries. A very remarkable form of petroleum occurs here, namely what is called *elastic* bitumen. You will see how remarkably resilient and india-rubberlike a body it is. Of its formation or age I am unable to give any idea, and only know that this variety has been found in but one other mine in France.

You have also, from the same spot, some very curious illustrations of the way in which petroleum occurs. Here, for instance, are long tubes, evidently formed from inspissated petroleum, and here a piece of rock, the holes of which are filled with a semi-solid bitumen. Here is some tar from Coalbrookdale, Shropshire, another ancient source of bitumen; and here again are a number of specimens of oils from Italy. Germany has recently developed a number of sources. At Oelhein, a light oil has long been found, closely resembling that of America, and at a great depth. In Bavaria, recent borings have been rewarded by a plentiful flow of light oil, rich in luminants and paraffin, which renders this variety equal to the best supplied by Pennsylvania; and in Alsatia and Austria springs are also being worked. It is singular that, with so many sources of liquid bitumen, there should be only this one spot which furnishes the solid variety, and that this should differ so widely from all the others; for, whereas the

richest petroleums yield under 10 per cent. of paraffin, ozokerit, by proper treatment, can be made to give 80 to 90 per cent. In fact, there is little doubt that this mineral is nothing more than solid high-melting point paraffin, with very small percentage of oil and dirt. This large specimen of ozokerit, as it comes from the mine, has been selected for me by the largest company in Galicia, and is as good an illustration of the natural mineral as can be wished. The fine crystals which project from it in different directions are rock salt, which is never far off an ozokerit mine. The dark striæ are gypsum, infiltrated with a small amount of tarry matter. Cutting off a corner of this lump, you see, characteristic of the mineral, a deep golden yellow wax, given by reflected light the greenish tint characteristic of all bitumens, which becomes more evident when the mineral is melted. As you see it here, although coated with the dirt of the mine, the ozokerit itself is nearly pure, all inorganic minerals traversing its substance in regular layers. By melting and clearing-down with a little acid these are readily removed. It is then cast into blocks of about one hundred weight each, which are either manufactured on the spot or exported. To obtain products from the mineral ozokerit which can be used commercially, one of two processes is resorted to. The first, which is most largely employed, is that of treating the crude wax with Nordhausen oil of vitriol, and heating it till the acid has become decomposed or evaporated. After proper decolorising, the wax assumes a golden yellow colour, and in appearance much resembles beeswax It is called *ceresin* from this resemblance, and can be brought to almost a pure white. Here are specimens of both white and yellow ceresin. This material, however, is not of much use for candle making, as it has a strong and unconquerable tendency to smoke, but its other uses are very great. It is largely employed as an adulterant of beeswax, in which, though, it can be readily detected by strong sulphuric acid, which decomposes the pure cerotate, leaving the mineral intact. To render ozokerit useful to the candle-maker, it has hitherto been necessary to distil it, although several patents have recently been taken out in which this process is discarded. Ujhely, who has devoted much attention to the working of earth wax, dissolves the crude material in benzine or some other spirit, in which condition it can be readily filtered through charcoal. The spirit is then distilled off in an air-tight apparatus, leaving the white paraffin behind. Preparations are being made, I am told, for carrying this out on a large scale. The process with which I am acquainted, and by which the ozokerit candles are produced, consists in distilling the crude mineral in a current of superheated steam, the apparatus employed being very similar to that used in distilling palm oil. I have on the platform the original experimental plant in which our first experiments were made. You notice the series of vertical tubes, each lower bend of which is furnished with a cock, from which the condensed distillate runs. The lighter vapours are caught in this so called "essence tank," where they are met by a jet of water, which carries them down with it. By this means, we obtain nearly 70 per cent. of a beautiful white paraffin, melting at 142° F. Of course, as it comes from the still, the ozokerit has not this appearance; it is a dirty grey, and is subjected to a series of treatments, similar to those undergone by paraffin wax, and already described. A very ingenious process for removing the oil from the paraffin without pressing has been patented by Mr. Sterry. It consists in simply washing the wax with soap and water. I have here a model of the apparatus employed. The impure paraffin is filled into bags, which are strapped on the larger of these two revolving cylinders of framework, and the trough being filled with a weak solution of alkaline soap, at a temperature of some 10° below the melting point of the paraffin, the big cylinder is revolved pressing firmly against the tooth-like ridges in the smaller. By this means the scale is thoroughly kneaded, and the oil to a great measure extracted, under the gracious influence of the warm alkali. The paraffin thus obtained is of a pure white, but opaque, which renders it useful for a certain class of candles only. A great agent in purifying the products of distillation is fuller's earth, which is capable of rendering the most refractory substances white and transparent.

Looking back now on all the materials which the animal, vegetable, and mineral worlds afford to the candle-maker, we have tallow, wax, sperm, palmitin, stearin, and paraffin. Tallow and wax candles have been separately described, as their mode of manufacture differs from the others, or mould candles. These were, until the commercial strain produced by Young's and Chevreul's discoveries had made itself strongly perceptible, made in hand-moulds—a comparatively slow and laborious process. I have here

one of the old hand-frames, which are not yet quite out of date, inasmuch as some people, for reasons best known to themselves, insist upon having their candles made in this manner; and also because there are certain sizes which are not in sufficient demand to justify making separate machines for them. As you see, the hand-frame consists of about two dozen moulds, held together by woodwork, opening into a trough at the top, the points being downwards. The wicks have to be carefully cut to size, and each one provided with a little cotton loop; a long piece of wire armed with a crochet-hook at the end is passed out through the tip of the mould, and catches the little loop aforesaid, which is then pulled up to the base, and a short piece of wire passed through it, which is kept in position by two little notches in the upper rim of the mould. The wick is then pulled tight by the end emerging from the top and secured by a little wooden peg. When all the moulds are thus furnished, the frame is ready for filling. This is accomplished by the pouring in of the material until the trough itself is quite full, thus allowing for the contraction of the liquid in the pipe which takes place on cooling, and is very considerable. The frame is then placed in water, the temperature of which is regulated according to the nature of the material—paraffin, for instance, requiring as cool a water as possible, sperm and stearine, tepid. When cooled, the superfluous material is removed from the trough by a sharp-edged trowel, and the candles extracted from the moulds by tapping the points with a mallet. The hand-made candle is readily distinguished by the little groove which the wire wick-holder makes in the base.

I am unable to say precisely when the candle-machine was invented—as far as I can learn, it was introduced into this country from America, about 1848-50. Mr. E. Cowles, of Hounslow, made several improvements therein, and brought it to its present state. He has been good enough to lend me these working models, which will assist my description. From 80 to 100 moulds are enclosed in the casting box, which moulds are open at each end. The tip which forms the top of the candle is fastened to a tube of iron, through which the wick passes. These tubes are fastened to a platform (Fig. 1, p. 886), moved up and down by a rack and pinion. The wicks are wound on bobbins, enclosed in the case below. The candles, being filled into the moulds, are cooled by water surrounding the pipes, the temperature of which can be regulated by the admission of steam, through pipes at the side. When hard, the crank is turned, which works the rack and pinion, and pushes up the tips, with tubes attached. These carry up the candles, which, on emerging, are grasped by an apparatus called a nipper, made of wood, lined with India-rubber. Here you see, my assistant is raising the candles, as I have described. When the candles are fully withdrawn, and held in position by the nipper, the platfom with wick pipes and tips is lowered to its normal position, thus closing the ends of the moulds, and these are again filled. As soon as the superficial cake has solidified sufficiently to ensure the steadiness of the wick, the candles above, which have hitherto acted as wick-holders, are cut loose, and removed in the nipper. Thus twenty or thirty batches can be made from one set of wicks.

A great improvement in the candle was made in 1861, when Mr. J. Lyon Field patented the conical "butt," by which a candle could be adapted to any candlestick, without paper or scraping. This invention naturally demanded a different machine for carrying out its purport, as, the butt being taper, and larger at the point of junction with the candle, than the diameter of the same, it would have been impossible to extract it from an ordinary mould. The diagram shows how this difficulty was overcome (Fig. 2, p. 887). The moulds for the butts are cast in a separate frame, which is removed, when the candles are finished, by a chain and pulley, and the candles then pushed out of the stem moulds in the ordinary manner. The idea is not mechanical, and several other neater methods have lately been patented, with varying success.

The temperature at which the candles are poured, and the time allowed for cooling, requires much care and experience to determine. When stearine candles were first introduced, their tendency to crystallise was so great, that it militated against their introduction. Various ways of remedying this defect were resorted to—actually *arsenic* being employed—until the simple expedient of allowing the melted material to cool in the pan, under constant stirring, till close on the point of solidifying, and then pouring into warm moulds, entirely put a stop to the nuisance. The wicks also of the candles, are an endless source of care. Every description and size of candle has its particular wick, of so many plaits, and so many threads. The wicks, again, have to be soaked in various prepara-

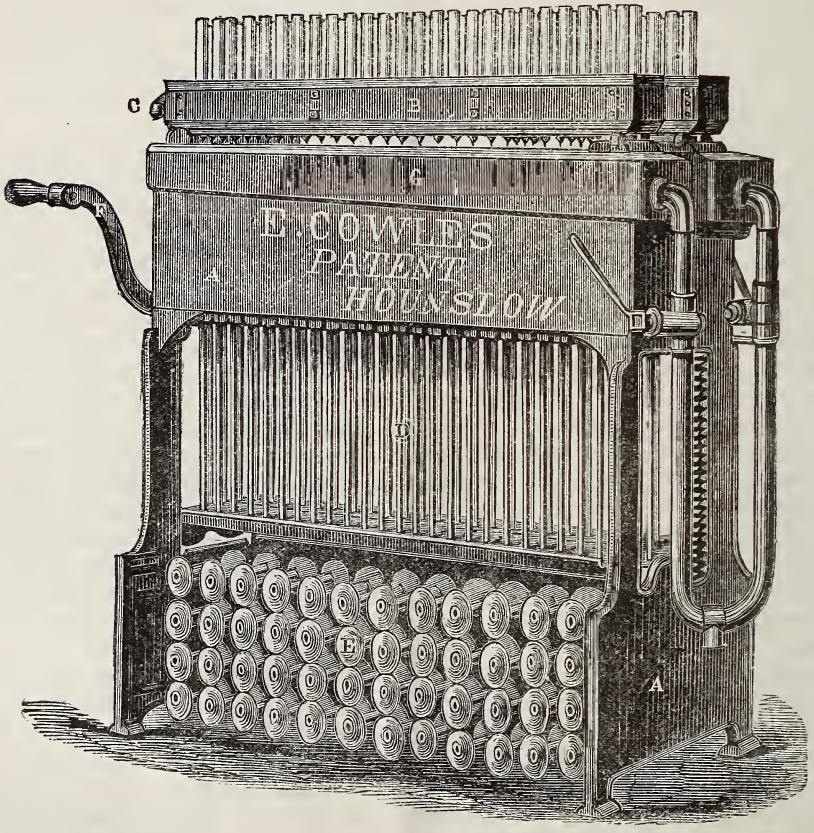
tions, accordingly as they are for wax, sperm, or stearine. Upon the ornamentation of candles, too, endless knowledge and skill has been expended. These wax candles, about fifty years old, heavy with vermilion and ultramarine, and

"With uncouth sculpture decked"

compare poorly with the exquisite forms and tints of the myriad lights on this table. The introduction of aniline colours into paraffin is a pretty discovery. You will see that, when I add a little magenta base to this beaker of paraffin, the liquid is not coloured at all. I now dissolve the dye in stearine, forming stearate of magenta, and a drop of this, added to the paraffin, dyes it of a gorgeous pink.

We have here candles cut and carved into every grotesque and beautiful shape—the spiral, the cable, the King Alfred, and the fluted—also a great variety of inventions, based on the even burning of a candle in a case, forced up by a spring. This horological candle, for instance, where the spirally ascending spring revolves a clock-glass, illuminated

FIG. 1.

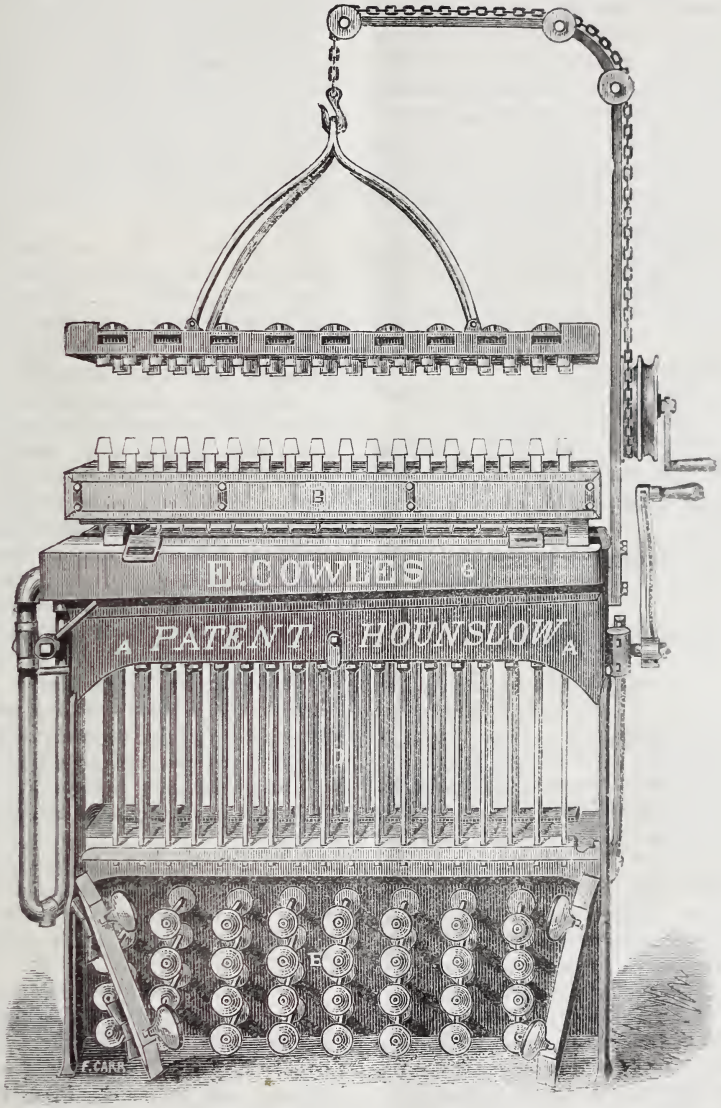


by the candle within. These dumpy little candles are the so-called "moons," which are employed in spring lamps for carriages and signals. Then there are many pretty ideas for preventing guttering, and supplying a shade which shall descend with the candle, all of which are explained better by examination than description.

I must confess, though, that, to my taste, nothing is to be compared, for elegance, with a plain, white, transparent candle. Stearine candles are undoubtedly the best for work, as they never bend or gutter; but the dead white is not pleasant, and the light is not equal in brilliancy to that of paraffin. Sperm candles are also very beautiful, and it is rather surprising that they are not more used; the price, perhaps, has much to do with this. The great objection to paraffin candles is their liability to gutter, if of low melting point, and further, to bend. This plasticity of paraffin is a very curious phenomenon, as it does not seem to

be affected by the melting point, except in the time taken to acquire it. Ozokerit-paraffin is of so high a melting point, that the candle is consumed, generally, before the bending point is reached. Here you will observe various paraffin candles, which have been kept in a steam cupboard, at a temperature of about 100°, for an hour. The melting points vary from 115° to 140°; the latter being ozokerit. All, you see, have bent, that of 115° nearly double, but the ozokerit has not even a slight curvature. This valuable property arises, no doubt, from

FIG. 2.



the homogeneity of the earth-paraffin, while all others are mixtures of higher and lower homologues. The light of an ozokerit candle is as 10 : 7.5 of sperm, 7 of wax, 7·25 of stearic acid, and 3·5 tallow. But there can be no question that no paraffin candle, as yet, gives the amount of light which it should by theory, and which it would do were its substance vaporised in a lamp. The cost of a candle will always transcend that of other forms of luminants, but its convenience and safety, on the other hand, more than compensate for this

inequality, where comfort is allowed to enter into consideration of economy. The still, the supply pipe, the burner, all are condensed into one little apparatus, and remain equi-distant, and the supply equable to the demand, till the end. This it is, combined with the purity of the combustion products, that has secured the candle its popularity, and will continue to do so as long as lights are burnt by man.

Gas and electric lighting have taken high rank as sciences, and justly so, involving, as they do, such profound thought and supreme skill. But the candle and the lamp have also called forth the highest powers of great scientists to perfect them—Chevreul and Young laboured for little else, and they are now nearly perfect of their kind. So, while honouring to the full the authors of the greater lights, we must not forget the many workers whose labours have brought the candle from the crude, smoky wax and tallow, to the beautiful form and light it now owns, of whom more than six generations sleep in the shadow of old Lambeth church, with no other monument than that of a fair life and faithful toil.

To those of the craft, and others, who have so kindly and courteously assisted me with their knowledge and specimens, I here tender my hearty thanks.

Miscellaneous.

POST-OFFICE REPORT.

The twenty-ninth annual report of the Postmaster-General (the Right Hon. Henry Fawcett, M.P.), has just been issued, and the following particulars are obtained from it :—

The estimated number of letters delivered in the United Kingdom during the 12 months was 1,280,636,200, showing an increase of 4·2 per cent.; the number of post cards, 144,016,200, an increase of 6·4 per cent.; the number of book packets and circulars 288,206,400, an increase of 6·3 per cent.; and the number of newspapers, 140,682,600, being slightly less than last year. It is suggested that the decrease in newspapers may be attributable to increased facilities offered by railway companies for sending newspapers as parcels.

Letters.

It is estimated that the average number of letters per head of the population was—In England and Wales, 40; Scotland, 30; Ireland, 16; United Kingdom, 36.

Taking the latest returns available with respect to foreign countries (viz., those of 1881), the average number per head was—In the United States, 21; France, 15; Germany, 13; Italy, 6; Spain, 5.

The number of registered letters was 11,264,926, being an increase of 3·3 per cent.

The number of Post-offices has been increased by 488, making a total of 15,406 in the United Kingdom, of which 920 are head offices. 770 letter boxes have been added, making the total number of receptacles of all sorts for letters about 30,100.

The extra number of letters and packets dealt with in the central-office during the Christmas week was nearly 14,000,000, including 3 tons of registered letters, against 12½ millions and 4½ tons of registered letters in the previous year. The decrease in registered letters was probably due to the extended use of postal orders for the transmission of small sums.

The number of letters received in the returned letter-offices was 5,651,443, an increase of 196,558; of post cards, 596,614, an increase of 37,205; of book packets, 4,988,890, an increase of 287,596; and of newspapers, 477,978, an increase of 63,184. The increase in returned letters is about proportionate to the increase in correspondence. Of the letters 562,291 were unreturnable; 26,293 bore no address, and of this number 1,604 contained cash and cheques, &c., amounting to £6,016, the whole of which, with the exception of about £150, has already been returned to the senders. The total number of letters and packets containing value, showed an increase of 12,000. Notwithstanding repeated warnings to the public, nearly 30,000 articles were received loose and coverless, owing to the weak and flimsy nature of the wrappers used, and the insecure mode of packing.

One firm in London posted as many as 132,000 letters for a single despatch, and another firm 167,000 post cards, and on other occasions there have been very heavy postings of circulars by individual firms, ranging from 144,000 to 456,000 in number.

Under authority of the Act passed last year, reply post cards, both inland and foreign, have been introduced; but hitherto the public have not availed themselves to any great extent of the facility thus offered.

Telegraphs.

The number of telegraph messages was 32,092,026, being an increase of 746,165 only, as compared with 1,933,879 in 1881–2. This diminution in the rate of increase is partly to be accounted for by the fact that two Easters, involving four holidays, occurred in the financial year.

The number of messages sent in London was 12,374,707, against 12,071,034 in 1881–2, being an increase of 303,673.

Although it has not yet been determined what form the intended reduction of tariff should take, it has been decided that, as soon as the necessary in-

crease of plant can be effected, the minimum charge for inland telegrams will be reduced from 1s. to 6d.

One hundred and two additional post-offices, and forty-five railway station offices were opened for telegraph work, making the total number 5,742.

Telephones.

Additional telephone exchanges have been established by the Post-office at Newcastle-on-Tyne, Exeter, Falmouth, Middlesborough, Plymouth, West Hartlepool, Cork, Limerick, Londonderry, and Waterford. The exchange at Newcastle, to which there are upwards of 200 subscribers, has connecting lines to Sunderland, South Shields, Tyne Dock, North Shields, &c., and is being worked with great success. The nine companies to whom licenses have been granted for the establishment of telephone exchanges have now forty-seven exchanges in operation, viz., thirty-seven in England, eight in Scotland, and two in Ireland.

Savings Banks.

The business of the savings bank shows satisfactory progress. The total amount due to depositors, including interest (but exclusive of Government stock), at the close of the year, was £39,037,821, as compared with £36,194,495 on 31st December, 1881, showing an increase of £2,843,326. This is the largest annual increase since the establishment of the Post-office savings banks in 1861.

The deposits (exclusive of those for immediate investment in Government stock) were 6,110,208 in numbers, and £12,227,528 in amount, as compared with 5,676,066, amounting to £11,345,957, in 1881, and the withdrawals (excluding those relating to stock) were 1,918,544 in numbers, and £10,094,974 in amount, as compared with 1,712,866, amounting to £2,469,668, in 1881. The amount of interest credited to depositors was £891,629, as against £826,990 in 1881, showing an increase of £64,639.

The number of Post-office savings banks and money order offices was increased by 486, making the total number, on the 31st of December, 6,999. An increase of 82 has taken place up to the 31st of March, raising the total to 7,081.

The average amount of each deposit (not including stock investment business) was £2, the same as in 1881; while the average amount of each withdrawal was less than in the previous year, being £5 5s. 3d., as compared with £5 10s. 7d.

There were 788,858 accounts opened during the year, and 537,494 closed, as against 880,831 opened, and 458,191 closed in 1881.

The savings bank business in Ireland again showed a large increase, the number of deposits during the year having been 278,727, amounting to £752,673, as compared with 251,146, amounting to £662,170, in 1881.

The total amount of Government stock standing to the credit of depositors, at the close of the year, was £1,143,717, held by 16,609 persons, against £738,998, held by 11,812 persons, in 1881, an increase of £404,749 in the amount, and of 4,797 in the number.

Money Orders.

The records of the inland orders show a total of 14,306,297 in number, amounting to £25,223,763: being a decrease of 386,531 in number, as compared with last year, but an increase of £1,855,691 in amount; whereas the returns for 1881–2 showed a decrease of 1,636,648 in number, and £871,091 in amount, compared with 1880-1. It is estimated that about 50 per cent. of the total number of inland orders are for sums over £1. The foreign and the colonial orders show an increase, both in number and amount; and the total number of orders issued of every sort was 14,505,254, and the amount £25,754,355, as compared with 14,880,821, and £23,848,936 in 1881–2.

The rates of commission upon foreign money orders were reduced on the 1st of January last by one third, which will, it is believed, tend to an increase of this class of business. A money order convention was completed during the year between the United Kingdom and Portugal.

Postal Orders.

The postal order returns shows a large increase. About £3,451,000, as compared with £2,000,000 in 1881-2, were transmitted by means of these orders within the year, and no less than 7,980,328 orders were used. The 1s., 5s., 10s., and 20s. orders continue to be most in request. With a view to afford greater facilities, proposals for modifying and improving the present regulations, and for extending the system to the Colonies, are under consideration.

Revenue.

The gross revenue for the year was over £9,413,812, including £7,034,982 for postage on letters, postcards, newspapers, &c., and £1,768,060 for revenue from telegraphs. The expenditure was £6,352,064, including £3,911,519 for postal service, money order and postal order business, and £1,585,013 for telegraph service, including expenditure by other departments.* The net revenue was therefore £3,061,748, being a decrease of £38,727 on the previous year.

It will be observed that the increase of expenditure during the year was again very large. Much of this increase was due to the development of business, but there were also special items of outlay, for instance, £63,000 for the improvement of the letter carriers' position, £34,000 for the remuneration of sub-postmasters, £37,000 for improved telegraphic communication with Ireland, and 13,000 for a cable depôt.

The expenditure of the amount, £63,000, was caused by the extension to the entire system of good conduct

* The annual interest on the capital sum of £[illegible] raised by the Government for the purchase of the telegraphs, amounting to £326,417, is not borne on the Post-office votes, but is charged on the Consolidated Fund.

stripes, which had been previously confined to London. This has given great satisfaction to the letter carriers.

The stripes are of three classes, viz. :—1st class, three stripes; 2nd class, two stripes; 3rd class, one stripe. Each stripe entitles the wearer to a special allowance of 1s. a week, in addition to his wages.

The introduction of the parcels post on August 1st is alluded to in the report, but no particulars of the arrangements are given.

Lighting by electricity has been introduced into the Glasgow Post-office, and very successful experimental trials have been made in the London Central Telegraph-office. The extension of this new mode of illumination is under consideration.

THE SWISS NATIONAL EXHIBITION AT ZURICH.

Amongst the forty-two groups into which the objects at the above Exhibition are classified, there are some which represent, in a detailed manner, certain peculiar features of Swiss industry. Amongst the various divisions, those connected with watchmaking, musical instruments, jewellery, arms, and scientific instruments, may appropriately be considered together, as typical of that minute and patient work for which the Swiss workman seems by nature peculiarly fitted.

This circumstance is particularly noticeable with respect to the development of the art of measuring time. Skilfulness of hand seems to be hereditary, as also the artistic instinct which guides the delicate tools used.

There is, no doubt, much to be attributed to the favourable climate of Switzerland, and to its comparative freedom from those extremes of heat and cold, which would impede the labour of workmen at an occupation principally of a sedentary character. An important cause of the progress of horological science is, however, the spirit of scientific research which has long been active in the country, and to which are due many institutions of practical utility. Amongst these may be cited the establishments at Neuchatel, at Geneva, for testing instruments of precision, as well as a control office at Biel for regulating ordinary watches, and the watchmaking schools at Geneva, Locle, La Chaux-de-Fonds, Neuchatel, St. Imier, Biel, Fleurier, and Pruntrut. There are mechanical workshops attached to the Geneva and Biel institutions, and in some localities there are special drawing schools. The plentiful supply of water power furnished by the streams flowing from the Jura formation, is an important element amongst the industrial advantages of the watchmaking districts. Various societies (with periodical journals) tend to keep before those interested the points of interest which arise with reference to the commercial and technical progress of the industry.

The historical features of the trade are dealt with by Herr Brönnimann, of Biel, in the official report issued by the exhibition authorities. The introduction of watchmaking seems to have taken place in 1587. Its extension dates, however, from the year 1680, when Daniel Jean Richard made the first Neuchatel watch at La Sagne, after which the industry spread to other parts of the canton. In 1748, watchmaking was established in the canton of Vaud. About the middle of the present century it was started in the cantons of Berne and Soleure. It also extended its operations towards the north of the country (Schaffhausen and Waldenburg), as well as to the south (Arogno).

Geneva is the central point of the manufacture of fine watches, the progress achieved by decorative art at that centre of industry, allowing of considerable ornamental taste being displayed. In the canton of Neuchatel, La Chaux-de-Fonds is the commercial centre, while Locle is the home of the watch industry. The various factories are distinguished by the variety of their productions, as they produce not only ordinary watches, but also complicated instruments of precision. Jouxthal (Vaud) is known as being the principal centre for the manufacture of repeaters, while Sainte-Croix produces good watches for the ordinary trade demand. The manufacture of watches by machinery has made special progress in the canton of Berne, ordinary descriptions forming the chief part of the wares produced. Machine work is also the specialty of Soleure, Schaffhausen, and several other districts. The most recent feature in Switzerland has been the general improvements in ordinary watches, which has taken place since the Philadelphia Exhibition of 1876. The new law as to the fineness of gold and silver is considered to have been of general advantage. The total annual value of the wares produced is estimated at about 4,000,000 sterling.

The display of watchmaking and its adjuncts is on a scale commensurate with its position as a national industry of the first rank, no less than 291 separate exhibits serving to illustrate its various features. The principal divisions of the group are instruments of precision, ordinary watches, fittings and detached pieces, electric clocks, &c., and tools.

The group which deals with goldsmiths' work and jewellery is much smaller than the watchmaking display, numbering only 30 contributors. In the middle ages the history of the craft in Switzerland differs but little in its features from the situation in other countries. In the 16th century, German wares of this description seem to have gained an entrance, and numerous specimens of Augsburg and Nuremberg work are to found in the possession of churches and guilds, and in private collections. The domestic industry then strove resolutely to compete with that of Germany, and the Swiss work of the 17th century is considered to possess a fair share of artistic merit. The productions of Peter Oeri, of Zurich, and Hans Peter Staffelbach, of Sursee, were known at the Court of Louis XIV. The ornamental style

of the national costumes was the source of much trade for the craft. At the commencement of the present century, foreign taste began to prevail, and the manufacturing processes of the new-fashioned wares being of a character requiring costly and numerous tools and machines. The smaller class of goldsmiths were obliged to obtain their goods from the factories of Geneva, and also to import them to some extent. Thus Geneva acquired a gradually increasing home trade for its wares, while its exports to Italy, Spain, Germany, and the East likewise increased. In 1685, there were 200 workmen employed in this branch, while at the present there are about 800, who are divided amongst the 60 manufacturing establishments to be found in Geneva.

The manufacture of scientific instruments and appliances forms a distinct branch of Swiss industry, which has, to some extent, grown out of its watchmaking trade. Aarau is one of the most important centres of this industry, which is also established at Berne and Geneva. The productions of Geneva manufacturers at the Bâsle and Neuchatel observatories are considered as meritorious specimens of their respective kinds. In telegraphic appliances Switzerland has a well-deserved repute; electric clocks and time telegraphs are to be met with in Switzerland upon a scale of singular completeness, all the more important towns possessing a network of electric clocks. The exact time is daily transmitted by automatic appliances from the Neuchatel Observatory to a number of places in the canton. The Swiss appliances for this purpose seem to have been adopted in other countries. The factories producing electric light appliances, situated at Zurich, Geneva, Bâsle, Neuchatel, &c., are said to be quite able to supply the wants of the country. Telephonic communication exists in Switzerland upon an extensive scale, having been adopted there earlier than in several other countries of Europe. The work produced in connection with this branch was at one time manufactured with the idea of aiming at as low prices as possible; but now the value of good material and careful workmanship is more fully recognised. Electric bells are met with in Switzerland in all buildings supposed to possess a certain standard of comfort in their internal arrangements.

The special features of the musical instrument manufacture in Switzerland (as far as export trade is concerned) are its industries at Zurich and Geneva, occupied in the production of pianinos and musical boxes. The alphorn is the special national instrument of the Swiss mountainous districts, and is of very primitive construction. In some localities it has now been replaced by the more convenient *Stockbügel*, somewhat like a trumpet in form.

The representation of printing, wood-engraving, photography, and kindred subjects, is not inappropriate, when it is considered how much science owes to these methods of diffusing knowledge. It is rather surprising to learn from the official report that book-publishing is only of limited extent in Switzerland, this fact being explained by the tri-lingual division of the country. The French and Italian cantons follow the usual written form of their respective tongues; but with respect to German, the Federation has adopted a national orthography, differing even from the new German system. This arrangement has only found partial acceptance, even amongst the German-speaking population of Switzerland; the important cantons of Basel and Schaffhausen still adhering to the old form. Journalistic literature is, on the other hand, extensively developed. Wood-engraving suffers to some extent from the relative scarcity of talented artists, and enterprising publishers: but zinc-etching has made a good deal of progress within the last ten years. As a specimen of what Switzerland can produce, the exhibition catalogue is specially worthy of notice for the clearness of its type, and the generally lucid arrangement of its contents.

The history of the introduction of photography in Switzerland has but few points of special note, but it is recorded that its diffusion is very general throughout the country. Reference is made in the official remarks on the subject, to the fact that Wothly, of Aix-la-Chapelle (who contributed in an important degree to the progress of the art on the Continent), was a native of Switzerland.

The cartographic delineation of the country is a subject which has engaged for many years the attention of the federal Government, and the progress made is illustrated by the cantonal exhibits in this group, contributed by the local authorities of Berne, Fribourg, Geneva, Lucerne, Neuchatel, Schaffhausen, Soleure, Thurgau, Vaud, and Zurich.

POPPY SEEDS.

The following letter of Surgeon-General Balfour to the Under Secretary of State for India has been communicated by the writer:—

From Surgeon-General Balfour to the Under Secretary of State for India.

2, Oxford-square, Hyde park,
London, 6th July, 1883.

SIR,—During the bygone nine years, the quantities of poppy seeds exported from India have been on the increase, giving an outlet to a product which was formerly only locally used, and employing a considerable amount of tonnage.

I beg to place on the margin the countries to which it was shipped in the year 1881-2, and it would be of value to India, and to the mercantile and manufacturing communities of Europe, if information could be obtained as to the purposes for which, in France and the United Kingdom, such large quantities are utilised. In all probability it is pressed for the oil, which may be used as a substitute for olive oil.

It has been a subject of inquiry by Deputy-Surgeon-

General Day, with myself, as to what oils are used for the sardines of the Mediterranaan, in order that he might be able to recommend the same for the pilchard trade.—I have the honour to be, Sir, your obedient servant,

EDWARD BALFOUR.

Year.	Cwt.	Value in Rs.
1874-5	402,296	22,12,58
1875-6	253,326	13,54,194
1876-7	351,133	18,43,647
1877-8	449,394	26,45,257
1878-9	249,072	16,60,749
1879-80	530,382	37,51,347
1880-1	579,544	39,76,254
1881-2	603,289	39,64,065
1882-3	571,542	30,26,401

Country.	Cwt.	Value in Rs.
France	346,031	22,50,871
United Kingdom.....	170,493	11,04,984
Belgium.....	74,582	4,71,259
Egypt.....	9,111	57,634
Holland.....	1,869	11,680
Germany	1,000	6,250
Other countries.....	203	1,417
Total	603,289	39,04,065

Sir Louis Mallet, in his answer to Surgeon-General Balfour, enclosed a letter from the Board of Trade, signed by Mr. Giffen, containing the following particulars:—"The seeds in question are classified in the 'Import List' amongst the unenumerated seeds from which oil is expressed, and the Board of Trade have no information as to the uses to which they are applied. It appears, however, from a communication which has been received from Mr. Dyer, the Assistant Director of the Royal Botanical Gardens at Kew, that these seeds yield about 50 per cent. of a very valuable oil, which is easily decolorised, dries well, and remains fluid to a low temperature, and it is understood that this oil has long been recommended as a substitute for olive oil."

General Notes.

MINERALS IN THE UNITED STATES.—A writer in the *Scientific American* states that, within 500 miles of New York city, there is a large section of country, comprising from 12,000 to 14,000 square miles, which, for the quality and variety of its minerals, is in all probability the richest and most interesting mineral country in the world, and one not surpassed by Saxony, in Europe. This remarkable section lies on the borders of Kentucky, Tennessee, North Carolina, and West Virginia. Seventeen counties of Virginia are included in it, and to these may be added Ashe, Alleghany, and Wantanga counties in North Carolina, which form an integral part of the same geological formation, and contain the same kind of minerals. In this section are to be found gold, silver, copper, lead, zinc, nickel, iron, manganese, plumbago, arsenic, antimony, limestone, gypsum, salt, barytes, kaolin, feldspar, soapstone, fireclay, asbestos, talc, mica, umber, millstone grit, marble, sandstone, granite, syenite, and many of the minor minerals useful in arts and manufactures. Besides this, the country is finely timbered, from the valleys to the mountain tops, with white oak, walnut, maple, tulip-tree, basswood, hickory, cherry, chestnut, buckeye, cucumber-tree, and other oaks, dogwood, white pine, black pine, spruce, cedar, and many other useful and valuable woods. It is also a fine agricultural district.

NEW PAPER-MAKING SUBSTANCE.—The great and growing increase in the consumption of paper, and the corresponding scarcity of rags, naturally cause attention to be turned to substances suitable for the paper manufacturer. Already the alfa and the ramie have been pressed into his service; and the same country which produces these, viz., Algeria, also affords another plant which, while being useful for this purpose, is, at the same time, a great enemy to the agriculturist. This is the dwarf palm, the fibrous properties of which have long been known to the Arabs, while they have been unable to turn them to account. A Frenchman, M. Reynaud, has found means for utilising the whole plant, except the roots, which serve for firing. Every part, from the stalk to the top-most leaves is transformed into fibre of excellent quality, and it makes no difference if the plants have been pulled up several years previously. The plants are placed in a kind of cage, which is immersed in a boiler filled with a special lye, and heated. The substance being thus retted, becomes soft, so that the fibre may be readily separated. It is withdrawn from the bath, and drained, the lye being saved for use over again. It is then passed between rollers, while at the same time being made cold by quantities of water. The number of rollings, rincings, and combings depend upon the degree of fineness required. At last, the product is allowed to fall into a receptacle containing pure water, whence it is withdrawn to be tied up in bundles for transport. The vegetable hair which may also be obtained from this plant is finer and more tenacious than any other known; it readily takes all the ordinary dyes, even without being bleached. As the whole of the tannin which it contains is not extracted, this plant is not liable to decay, while it is, at the same time, antiseptic, on account of its aromatic odour, and to some extent impermeable by water.

Journal of the Society of Arts.

No. 1,605. Vol. XXXII.

FRIDAY, AUGUST 24, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PREMIUMS FOR THE 129th SESSION.

The following Prizes are offered by the Council for the year 1883:—

John Stock Prize.—A Society's Gold Medal, or £20, for the best design from a poem, or from history, or from the Scriptures, prepared with a view to Mural Decoration.

Benjamin Shaw Prize.—1. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the operations of coal-mining." 2. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the manufacture, storage, and transport of explosives."

The Council leave it to the competitors to bring the plans under their notice in any way they may think proper, whether by model, written description, or otherwise.

Howard Prize.—A prize of £100 for the best Essay on the Utilisation of Electricity for Motive Power. Preference will be given to that Essay which, besides setting forth the theory of the subject, contains records with detailed results of actual working or experiment. The Society reserves the right of publishing the Prize Essay.

Fothergill Prize.—A Society's Gold Medal, or £20, is now offered for the best Invention having for its object the Prevention or Extinction of Fires in Theatres, or other places of public amusement.

Mulready Prize.—A Society's Gold Medal, "to that student in a School of Art in the United Kingdom, who exhibits the best Drawing from the nude figure, executed in black and red chalk, in the manner so successfully practised by Mulready."

Designs, plans, models, essays, descriptions, inventions, &c., intended to compete for any of the above Prizes, must be sent in on or before the 31st October, 1883, to the Secretary of the Society of Arts, John-street, Adelphi, London.

Further particulars relating to the Prizes may be obtained on application to the Secretary.

Miscellaneous.

FIBRE PLANTS OF INDIA.

By J. W. Minchin (of Ootacamund, Madras Pres.

The cultivation and treatment of fibre plants in India, has occupied the attention of the Society of Arts on several occasions. The great botanist, Dr. Forbes Royle, first suggested the importance of the fibre-producing plants of India in 1854; and Dr. Forbes Watson, in an exhaustive paper before the Society, in 1860, enumerated the most important varieties; having, with the assistance of the Indian Government, collected specimens, and prepared plates representing them, which were published in the *Journal* of the Society (vol. viii. p. 448). Mr. Leonard Wray read a paper on Indian fibres in 1869, and it was again the subject of an article by Mr. P. L. Simmonds, in 1873.

Notwithstanding these frequent discussions, and the thorough knowledge that has been obtained of the value of the different principal Indian fibres, and of their cultivation and production, there has been no great commercial movement in the export of these fibres, and this is due to the difficulty that has been encountered in the treatment. The cost of preparing the fibre for the market by the native method of hand-scraping being prohibitive, and no machines or process for the economical preparation on a large scale having, until lately, been introduced.

For the valuable fibres strength and brightness of colour are essential. The ordinary process of retting or fermentation in stagnant water cannot be followed.

The *Corchorus*, or jute fibre, is used principally for coarse bags, and such purposes where the strength and colour of the fibre is not important. It can be produced at a very cheap cost: the cultivation of an acre of jute is estimated at Rs. 10 for the labour, and about half-a-ton of fibre is the usual crop; while by the retting process, one man can prepare for

market about two cwt. of fibre in the day. The cultivation of jute has been taken up largely by the natives in India. The export stated by Dr. Forbes Watson in his tables, in 1860, at 88,000,000 lbs., had amounted in 1874 to 560,000,000, or seven-fold in the fourteen years. For the more valuable fibres this retting process is not available; a man can prepare only 5 lbs. to 12 lbs. of rhea or Manilla hemp fibre in a day by hand-scraping, while the waste is enormous.

The necessity for some mechanical treatment has been long recognised. In 1872, the Government of India offered a reward of £5,000 for any machine that could separate rhea fibre in a green state, at a cost not exceeding £15 per ton. The conditions were not fulfilled, but a reward of £1,500 was given to Messrs. Greig, for relatively good results. The reward has since been withdrawn. The cultivation of rhea has now been successfully introduced into the South of France, Algeria, and the Southern States of America; and the attention of scientific men to some chemical or mechanical treatment has been continued.

There are now two machines and two processes that claim to treat green fibre successfully. This being accomplished, the golden hopes of Dr. Forbes Royle and of Dr. Forbes Watson, as to the future of Indian fibre, may be realised.

As the soil and climate of the hill districts of Southern India and Ceylon, with which I have been connected for the past twenty-five years, seem to me to be specially adapted to the cultivation of fibre plants; and as the introduction of any new industry is at the present time urgently wanted by the European planters settled in those portions of our Eastern Empire, I have ventured to bring the subject forward again, for the purpose of urging the adaptability of this cultivation to the circumstances of the hill planters; and the fact that lately invented chemical and mechanical processes have supplied the economical and commercial prospects of success which have so long been desired.

The following fibre plants are suitable for cultivation in the hill districts of Southern India:—Rhea (*Urtica utilis*), Neilgherry nettle (*Urtica heterophylla*)—these are dicotyledons, or exogenous plants, the fibres residing in their bark or bast—plantain (*Musa paradisiaca*), wild plantain, Manilla hemp (*Musa textilia*), aloe (*Agave Americana*), pine-apple (*Bromelia ananas*), wild pine-apple (*Bromelia sylvestris*, mooga, or bow-string hemp (*Sansevierazeylanica*), mudar (or *Calatropis gigantea*)—which are monocotyledons, or endogenous plants, the fibres being embedded in the pulp of their roots, stems, and leaves. These, and other kindred plants are indigenous to India, and can be cultivated without difficulty.

Rhea (*Urtica utilis*), *Boehmeria nivea ramia*—China grass—is a perennial plant. In China, fields of rhea are said to last, with care and manure for 80 to 100 years. It grows in Sikkim and Nepaul at an altitude of 3,000 feet. It has been cultivated successfully on many coffee estates in India and Ceylon; but it requires rich unexhausted soil. It grows with the greatest vigour in damp warm climates. In the islands of the Indian Archipelago it is cultivated under shade. It requires a light but fertile soil, but it must be well drained. It is propagated from the separated roots, from layers, slips, or cuttings; in this way five cuttings of grown stems can be expected in the year after planting; from seed, no crop can be expected before the third year.

M. Favier describes the plant as giving out several stems, of which the number increases in proportion to the development of the root, which forms a kind of tuft or bush. The stems are woody, and have the appearance of thick strong rods, the height varying from 5 to 12 feet. The roots, slips, or layers should be planted 18 inches apart, and after the first crop the alternate rows should be transplanted into new fields, leaving the remainder, about 3,500 plants per acre, to spread and cover the ground. The yield in Java is said to be 44 stems per year from each stool, taken in four cuttings. Each stem in its green state weighs about 1 lb.; 100 lbs. weight of green stems yields 5 lbs. of a raw fibre or filament, which, by Muspratt's analysis, as quoted by M. Favier, contains 66 per cent. of pure cellulose. In the official reports to the India-office, with native hand treatment, the crop is said to be 1,000 lbs. of raw fibre per acre, taken in four cuttings. M. Favier states that, in Algeria, 1,400 lbs. of fibrous thongs was the crop per acre, as calculated by Mr. Hardy, ex-Director of the Botanical Gardens there, while in the South of France as much as 1,600 lbs. of filament have been obtained to the acre.

Mr. P. L. Simmonds, in his article in 1873 (*Journal*, vol. xxi., p. 762), stated that the crop gathered in Jamaica amounted to 300 lbs. per acre at each cutting, and that there had been five cuttings in the year, making the yield three-fourths of a ton per acre per year. While Mr. Bainbridge, in the discussion on Mr. L. Wray's paper, in 1869, stated that the result of his own experience in Assam was 750 lbs. green nettles, which gave 45 lbs. weight of fibre in each of three cuttings, making only 135 lbs. per acre per year (*Journal*, vol. xix., p. 453). The yield appears to depend on soil, climate, and treatment. The properties of the rhea fibre place it in the first position among vegetable fibres; it is second to none in strength, while the fineness or attenuation of the fibre places it before flax, and it is equalled only by the pine-apple fibre. It can be used for any textile purpose, having been mixed with cotton, wool, and silk, to advantage; it is in special demand for sailcloth, table napery, curtains, and tapestry; but from the very limited supply as yet available, the applications of this beautiful fibre are yet in their infancy.

Neilgherry nettle (*Urtica heterophylla*) is an annual, and can be readily grown from seed, giving its crop

in about seven months. It gives a strong white glossy fibre, and a sample, hand cleaned, was valued at £125 per ton. The cultivation has not been tried on a commercial scale; the difficulty will be in the cultivation and collection of the crop, as the leaves and stem are armed with a most poisonous sting. It has occupied the attention of planters on the hills for many years past, but no means of treatment was known.

Plantain (*Musa paradisiaca*) is generally cultivated for its fruit; it should be planted about six feet apart, and each stem will give about 4 lbs. of raw fibre, and 50 lbs. of fruit per year. The fibre is fine, white, and silky; long, light, and strong. The quality depends on the mode of cultivation and treatment; but it is not so valuable as Manilla hemp. The Government of India have constantly urged the value of this material for paper making; but no use has ever been made of the millions of trees grown in India for their fruit. The stems are cut down and left after the fruit is moved.

Manilla hemp (*Musa sylvestris*) has been successfully grown in Wynaad and other hill districts, since 1864; but hitherto to no commercial value, from inability to treat the fibre. It is grown extensively in Manilla, where 250,000 acres are planted with this staple; it has hitherto been treated only by hand, the natives preparing about 12 lbs. weight of fibre per day, and receiving one half its value for the work, the waste being so great that only about 1 lb. of fibre is obtained from each tree. Yet notwithstanding this, the exports have amounted to 35,000 tons annually. Manilla hemp is imported into Europe and America for rope-making only, and is worth £20 to £60 per ton, according to quality; the crop may be taken at from 10 cwt. to 2 tons per acre, according to successful treatment.

Aloe (*Agave Americana*) will thrive on any sterile waste land, and is now common throughout India. The cultivation is being extensively carried on in Mexico, where 5,000 plants may be found in an acre. It comes to full growth in three years, and can easily be propagated from suckers. The fibre is principally used for mixture with Manilla hemp in the manufacture of cordage, and is worth about £10 per ton less than Manilla hemp.

Pine-apple (*Bromelia ananas*) and (*Bromelia sylvestris*) produce a very valuable fibre. The former is cultivated for its fruit in all coffee estates, and the latter is found in large quantities in all the jungle swamps in the hill districts. The fibre is valued at £45 to £55 per ton.

Bow-string hemp (*Sanswiera zeylanica*) can be propagated on almost any soil, from the slips which issue in great abundance from the roots; it is perennial; the wild leaves are from 12 to 16 inches long, but under cultivation attain 3 to 4 feet. Dr. Roxburgh estimated that an acre of land would produce three-fourths of a ton of clean fibre.

Mudar tam. zercum (*Calatropis gigantea*) is common on all waste places in India. Mr. G. W. Strettel, of the Indian Forest Department, in his pamphlet, "A New Source of Revenue for India," published in 1878, urges the value of this product on the attention of the Indian Government. It comes to maturity in a year, is perennial, and requires no care. Mr. Strettel estimates the cost of bringing an acre into cultivation, planting four feet apart, at £2 9s. 8d., after which the only recurring expense would be for harvesting and treatment. He estimates that it will yield a crop of from five to seven hundred weight per acre yearly, and the fibre is pronounced equal to good flax, and therefore worth £40 to £50 per ton.

The treatment of green fibre has now been successfully accomplished by the following machines and processes:—

1. The machine of Messrs. Death and Ellwood, of which over one thousand are now in use, for extracting fibre from all kinds of aloe, plantain, and pine-apple, &c., in Mauritius, Canary Islands, Africa, &c. It is almost the only machine in use for extracting Henquin fibre or Sisal hemp, and Ixtle or wild pine-apple fibre, in Central America, of which 17,000,000 lbs. weight are now exported annually. It is being tried in Manilla for the treatment of Manilla hemp. The jet of water which acts as an elastic cushion on which the fibre is beaten, to clear it of boon and useless particles, acting also most satisfactorily in removing the gummy matter which causes the principal difficulty in the treatment.

2. An ingenious invention of M. Roquet, a Frenchman, for crushing and scutching vegetable fibres at one operation, which has been patented by Mr. W. M. Adams in this country and elsewhere. It treats all kinds of dry fibres most thoroughly, and has also successfully treated green rhea fibre from Kew Gardens.

3. M. Favier, a Frenchman, has suggested a process of treatment for rhea fibre, by steaming the green stems in the field. This enables the easy decortication of the bast by cheap hand labour, at a very small expense, and saves the cost of carriage of the woody portion of the stems, these being used for the fuel of the boiler that creates the steam. The stem ashes can be at once returned to the field as manure, together with the leaves and waste, so that only the fibre itself is removed from the soil; by this process it is calculated that the fibre thongs can be obtained at a cost of 30s. per ton.

4. The process which is known as Ekman's patent, for the manufacture of cellulose or ultimate fibre from raw fibres, by treatment with the bisulphite of magnesia. This process consists in boiling the fibrous substance under a pressure of 90 lbs. of steam, in water containing sulphurous acid, in combination with sufficient magnesia to prevent the oxidation of the organic matter. This chemical treatment produces an ultimate fibre from the rhea plant, which is worth £168 per ton, or three times the value of the best cotton.

Seeing that it takes 100 lbs. of green rhea stems to

make 5 lbs. of raw fibre or filament, worth at the rate of £45 per ton in the English market. M. Favier's steaming process, which saves the carriage of the woody portion further than the field in which it is grown, is an economical consideration of the highest importance.

This raw fibre or filament, after treatment in M. Ekman's boilers, is reduced from 5 lbs., worth at the rate of £45 per ton, to 3½ lbs. of ultimate fibre, worth £168 per ton. When this process is undertaken by the grower in India, as soon as possible after cutting and decortication in the field, the fibre is saved from the damage that is constantly going on from fermentation, as long as the tannic gum is attached to it; it being impossible thoroughly to dry the fibre while this gum remains. There is no trouble in at once drying and packing the ultimate fibre. The cost of carriage to the manufacturing market is reduced to a minimum, and the pure fibre is in no way damaged by pressure in packing under screw or hydraulic press. At the same time the cultivator obtains the full manufacturing value, which is otherwise intercepted by the mill men, who scutch, comb, and prepare the fibre for textile uses.

It seems that for dicotyledons, or exogenous plants, such as rhea and Neilgherry nettle, M. Favier's steaming process, in conjunction with M. Ekman's bi-sulphate of magnesia process, have attained the desired object, economical and thorough treatment.

For the monocotyledons, or endogenous plants, such as plantain, Manilla hemp, aloe, pine-apple, &c., the machines of Messrs. Death and Ellwood, or M. Roquet, are required. For the coarser fibre obtained from these plants, no further treatment is necessary; these coarser fibres are used for rope-making. The finer fibres, such as those obtained from the *Bromelias*, and the selected finer portions from other kinds, may be advantageously treated in M. Ekman's boilers; while from the waste and inferior stuffs a paper pulp may be obtained which will be an important item in the receipts of the estate. In the cultivation of the fibre plants I have enumerated, the planters on the hill districts of South India will have varieties suited to every exigence of their soil and climate. For their exhausted fields, which are no longer suited for the cultivation of coffee, cinchona, or tea, there is aloe, mudar, or moorga available, which will flourish on the poorest and most exposed hill-sides. For their low lying rich valleys, at elevations too low for coffee or cinchona, such as the lower slopes of the Ghats, the cultivation of rhea fibre can be carried on; on the level land, where ploughing is possible, the Neilgherry nettle can be sown to advantage. The undrained swamps can be planted with the *Bromelia sylvestris*, and the borders of the streams and steep forest hills can be cultivated with plantain and Manilla hemp.

The store houses and water-power generally found on the coffee estates that have been erected for the preparations of the coffee crops, and which are unused for nine months in the year, will supply the motive-power for the scutching machinery, and drying accommodation for the fibre. It is probable that the cost of Ekman's boiling and chemical process may be too considerable for each individual planter; but some convenient central factory established in each district, or on the coast, may enable the planters to obtain the benefit of this process, on the same principle as is now in use for the ultimate preparation of their coffee. It therefore seems that good hope is afforded, that the cultivation of fibre plants may relieve the Indian and Ceylon coffee planters of much of the troubles that have befallen them, from the persistent attacks of the *Himcileia bastatrix*, or leaf disease.

THE FISHERIES EXHIBITION.

No. I.

The fact that more that a million and a quarter of persons have visited the Fisheries Exhibition since it was opened in the middle of May last, confirms its success as a commercial enterprise. But the anticipation of this form of success was not the origin of the movement which led to the magnificent display at South Kensington. The chief objects of the Fisheries Exhibition are the increase of our fish supply, the cheapening of its price as food for the people, and, at the same time, the improvement of the condition of our fishermen. These are the objects of the Exhibition, and hence a multiplicity of questions have been raised in reference to our fisheries, the practical solving of which has now engaged attention in a special manner during the last three months. Among them are the questions of overfishing certain grounds, or of fishing them at wrong seasons, or in an unfair manner; of imperfect fishery laws; of imperfect appliances for fishing; of the destruction of immature fish; of the transport of fish; and of market accommodation, and market operations.

These, and kindred questions, have been mooted more or less at previous Exhibitions, not only in this, but in other countries. Of the eighty or ninety Exhibitions, large and small, which may be said to be the offspring of the great World's Fair in Hyde-park, in the year 1851, many have paid some attention to fish and fishing, and some few have made this their principal object. First in order of date, and therefore of importance, comes the Exhibition of Amsterdam, as far back as 1861, the classification and arrangement of which provided a model for the others of the kind which have been held since. The ramifications of the subject are astonishing. To classify fish according to their characteristics is no light task in itself; but that is the merest trifle in comparison with the economic relations involved. Improvements in implements, improvements in fishermen's homes, improvements in the apparatus for saving life so constantly and so carelessly im-

perilled; the utilisation of products, the development of commerce; arrangements for conveyance, for sale, and for distribution; arrangements for apprenticeships, for harbour accommodation, for culture, and for acclimatisation, are a few of the topics to which this subject gives rise; and it is, therefore, no slight merit to have opened the eyes of the world to this vast field of utility and wealth. The object in view at Amsterdam was to instruct the population of Holland in the various modes in which fishing was carried on all over the world. Four years after this exhibition, Boulogne and Bergen opened their doors to the fishermen. Havre followed with a maritime exhibition in 1875; and in the same year Philadelphia presented a curious collection of papier-maché models of the principal fishes and crustacea of the United States. Finland, in the following year, devoted one section of its exhibition to "*skog shushallung, jagt, och fiske*," or forestry, hunting, and fishing. And it must not be forgotten that, in 1877, there was held at the Westminster Aquarium a maritime and piscatorial exhibition, the first of its kind in this country. In 1880, Berlin instituted her great Fisheries Exhibition; and in 1881 the success of the Norwich Exhibition was very marked. In 1882, Edinburgh followed suit with similar success; and in the same year Denmark had an exhibition of fishery produce, apparatus for artificial fish-culture, and utensils of every description employed for fishing purposes, in conjunction with an agricultural exhibition held at the same time at Svenborg, in the Danish island of Fuhnen. Again, too, not long since, our Dutch neighbours invited all the world with sporting proclivities to come to Cleves, and assist at an exhibition of sporting appliances, "engines," and *impedimenta* connected with the capture of animals *ferœ naturæ*, whether denizens of land, air, or water; and consequently piscatorial appliances held a conspicuous place. And now the Great Fisheries Exhibition in London is the outcome and climax of its predecessors. The members of the Royal Family, and especially the Prince of Wales, have taken an active interest in this Exhibition; while the executive committee, with its chairman, Mr. Birkbeck, M.P., and the whole staff of officials, have been unwearied in their exertions to make the project a success.

It is almost impossible to exaggerate the importance of the "harvest of the sea;" and the present Exhibition will have done great service, if only in impressing upon us the magnitude of the British fisheries industry. Statistics in reference to this are very interesting. It has been stated that, at the lowest calculation, 550,000 tons of fish are annually taken in British waters by our own fishermen. Of this quantity "Greater" London consumes over 130,000 tons, which is equal to 1,000 bullocks daily, and represents, roughly speaking, 90 lbs. of fish per annum for every man, woman, and child in the metropolis. This 550,000 tons is estimated as worth eleven millions of pounds sterling. About 35,000 boats and vessels are employed in our fisheries, and about 110,000 men and boys actually afloat. The above figures are semi-official, but many statisticians have put them much higher. For instance, it has been reckoned that there are little short of 200,000 fishermen on our coasts; but perhaps these figures may include some shore hands, and even women, who take an active part in the fishing industry. Then again, our yearly supplies of fish food have been set down by competent authorities as worth at from twelve to sixteen millions of pounds sterling, a large portion of that sum being expended in wages to fishermen, and in payment to those who build their boats and vessels, and make their nets and canvas. Some statistics, however, are still more trustworthy; for instance, those in reference to the Scotch herring fishery. Taking the average of the last five years, the annual value of Scotch herrings, fresh and cured, is equal to three millions sterling. The English and Irish herring fisheries may be reckoned at worth two millions. The mackerel fishery is also a very valuable one, and is pursued all along our coasts as the fish move from district to district. The harvest at Lowestoft and Yarmouth is during the months of May and June, and the fish are often so abundant that twenty thousand are taken in a single night. At Yarmouth this mackerel fishery employs ninety boats, with a tonnage of upwards of three thousand tons, and nearly nine hundred men, producing about twenty thousand sterling a-year.

Some interesting calculations, recently made *apropos* of the Exhibition, are as follows:—The annual value of herrings is put at over three and a-half millions sterling, of all kinds of round and flat fish at six millions, and of shell-fish of all kinds at three and a-half millions. Ten million pair of soles are annually consumed in Great Britain and Ireland; and seventy-two million oysters annually in London alone. Forty thousand a-year represents the value of whitebait brought to the metropolis. Sprats are consumed to the amount of sixty thousand sterling per annum in Great Britain; and the demand for "Finnan haddies" is so great that more than twenty-five million haddocks come into the "curers'" hands every year.

As one instance among many of the great development of a fishing industry, may be mentioned that connected with Great Grimsby. In the year 1853 there were but 12 fishing vessels in the port of Grimsby, and few facilities for trade. At the present time there are 825 vessels belonging to the port, solely engaged in fishing, with an estimated registered tonnage of 42,000, valued at £725,000, and carrying 4,710 men and boys. Besides the above, the port is frequently visited by many Dutch and other fishing vessels for the sale of their cargoes. The total area of fishing docks is 23 acres, with a market attached 1,600 feet long, where in the year 1882, over 73,000 tons of fish, were landed. There are 50,000 tons of ice imported annually, which is not only used by the smacks at sea, but for packing in the market, and is sent (cheaply) in various forms to all parts of the king-

dom. The railway company has expended nearly half-a-million sterling in the making of docks, and otherwise providing for the fishing trade, and is still extending and ever increasing conveniences. From 2,000 to 20,000 live codfish, besides a large quantity of other fish, are kept ready for sale in boxes in the fishing dock. The capital invested in the fishing trade of Grimsby may be put at a million sterling; and no less than 30,000 persons out of the population directly or indirectly obtain a livelihood from the fishing industry.

There is, and has long been, an impression that many of our sea fisheries are less productive now than formerly, and that the epithet of "barren," which Homer was once so fond of applying to the sea, may ultimately be applicable in another sense to that great liquid storehouse of food to which the Exhibition at Kensington is a striking tribute. To disprove this fallacy, the cumulative testimony of all the greatest authorities in the world, upon the prodigious inexhaustibly prolific abundance of the resources of the ocean, might easily be adduced. The sea, it is well-known, covers nearly two-thirds of the surface of the globe upon which we live, or, as Michelet puts it, "on the surface of the globe water is the rule, and dry land the exception." It is natural that man, who descends into the bowels of the earth in pursuit of the precious metals, should also explore the depths of the ocean, in search of that food with which M. Louis Figuier tells us that it everywhere abounds. Accepting Mr. Spencer Walpole, late Inspector of Fisheries to the Home Department, for a guide, one is almost tempted to wonder how, in presence of the inconceivable fecundity of the herring, there is room enough in the sea even for this single fish, without taking the many other finny denizens of the deep into calculation. "We know," observed Mr. Walpole, "that the Scotch fishermen, on an average, take thousands of millions of herrings every year. We know also that the Norwegian fishermen take from the North Sea another thousand million of herrings per annum; while I am sure that, from the same source, other fishermen take at least another thousand million." Mr. Walpole then proceeds to show that predacious birds and fishes kill at least as many herrings annually as fishermen do, and, therefore, it may be assumed, that man and other enemies draw no fewer than six thousand millions of herrings annually from one small district of the boundless ocean. "Now, I do not suppose," he continues, "that any one with the least knowledge of the subject would pretend that all these enemies of the herring, acting in combination, catch one out of every hundred that the North Sea contains. To put myself, however, beyond possibility of error, I will assume that they catch one in every two. Thus, at the end of the year, the account must be—six thousand millions of herrings taken, and six thousand millions left." Supposing that of those left half are females, it is obvious that, to maintain the stock, these females must produce two herrings apiece, to make up the needed complement of twelve thousand millions for next year. The female herring does not, however, lay two eggs—she lays from twenty to thirty thousand. If she be deemed capable—which is less than the truth—of laying ten thousand eggs annually, it is obvious that nature intends man and the herring's other enemies to destroy five thousand finny victims of this class, expecting that, out of the remaining five thousand, nearly all should perish." "If it were not so," adds Mr. Walpole, "the sea would be full of herrings."

Of a like nature is the evidence contributed by Mr. Frank Buckland. Those who read his remarks upon the amazing powers of reproduction possessed by the herring family, "which includes the common herring, the pilchard, the sprat, the two species of shad, and the anchovy," need not entertain any apprehensions as to the approaching exhaustion of our ocean fisheries, upon which so many sciolists and pessimists are fond of descanting. Professor Huxley has always maintained the same views. In his inaugural address a few weeks ago, in connection with the conferences at the Fisheries Exhibition, he urged that the supply of cod, herrings, and mackerel was practically inexhaustible. As an illustration of this, in one instance, he alluded to the "coming-in" of the cod on the coast of Norway in the months of January and February, which is one of the most wonderful sights of its kind in the world. The fish then form what is called a "cod's mountain," of from 120 feet to 180 feet deep, and the fishermen, when they let down their loaded lines, feel the lead knocking against the bodies of the fish for a long time before it gets to the bottom. The Professor said that, allowing each fish to be four feet long and to be a yard apart, there would be in a square mile of such a shoal something like 120,000,000 fish—a calculation which he said he believed was considerably under the mark. He went on to say that, as herrings were the main food of cod, if they allowed each cod in a square mile but only one herring a day, they would consume in the course of a week 840,000,000 herrings. He believed that the whole Norwegian herring-fishery had never yet reached half that total of fish; and, further, that all the fishing operations of all nations of the earth did not result in catching five per cent. of the fish which were the subject of the great sea fisheries—namely, cod, herrings, mackerels, pilchards, and the like.

At the same time, however, there is no denying the fact that various fish, once abundant, have, more or less, disappeared from their wonted banks, and that fishermen, in some instances, have to go three times as far, and to use three times the length of net and tackle generally to keep up their takes. The cause, or causes, of this disappearance of fish from certain fishery-grounds will, doubtless, be found treated on in some of the essays which have been sent in to the committee of the Exhibition, and the matter has been discussed at the conferences. It may be, as some economists assert, that the number of quadru-

peds whose flesh affords food for mankind, are decreasing absolutely and relatively, if compared with the increase of the population of the earth. Some economists unhesitatingly assert that the supply of fish is decreasing. And certainly they might instance soles as fish which have of late years become scarce, and consequently very dear. However, the old saying is true that, "There are as good fish in the sea as ever came out of it," and as many. What is required is, that they do come out of it, and in such quantities as will enable them to be sold to the masses of the people of these islands at a moderate cost; and, at the same time, that "the toilers of the sea" receive a fair remuneration for their arduous and dangerous labour.

MATE OR PARAGUAY TEA.

The following account of the Paraquay tea plant is taken from a translation published in the *Pharmaceutical Journal* of a paper by Dr. Theodore Peckolt in the *Zetischuft d. allg. öster. Apot.-Verein.*:—

This plant, which belongs to the holly family *(Ilicineæ)*, has several names in different parts of South America. In the Guarani language it is called *Caá*, which is the Indian word for leaf. The prepared leaves were named by the Spanish "yerba" (herb), and the infusion "mate" [unaccented] from the native name of the vessel in which the tea is made, and the drug is now generally known as mate in Brazilian commerce, although the Spaniards call it "yerva mate" or "yerva de palos." The name "congonha" has been said by some writers to be applied to mate, but this is an error, for the Brazilians understand by the names "congonha mansa" and "congonha brava," other trees belonging to the same natural order, which are used as a substitute for mate when it is not easily procurable.

The plant was first briefly described by St. Hilaire, in 1822, when he gave to it the name *Ilex paraguariensis*, which he altered, in 1826, to *Ilex Mate* subsequently publishing the first name again in 1833, and this is now adopted in the "Flora Brasiliensis." In 1824 the plant was described in detail by Lambert, under the name of *I. paraguensis*, and the plant illustrated from specimens from the Jesuit Missions. The synonyms stand as follows:—

Ilex paraguariensis, St. Hil.; *I. Mate*, St. Hil., *I. paraguayensis*, Hooker, fil.; *I. paraguensis*, D. Don.; *I. paraguariensis*, α, *obtusifolia*, Mart.; β, *acutifolia*, Mart.; *Cassine Gongonha*, Raben; *C. Gouguba*, Guibourt; *Chomelia amara*, Vell.

The mate plant attains the height of an apple tree, becoming even larger in favourable situations, but when cultivated and deprived from time to time of its leaves, it remains small and forms a mere bush. The leaves are shortly stalked, simple, wedge-shaped, obovate or elongate-lanceolate, toothed, dark green above, paler beneath, shining, of leathery consistence, one to three inches long, and one-eighth to one-and-a-half inch broad. The flowers are axillary, situated on one to three times forked peduncles, white, and of similar size to those of the common holly. The calyx consists of four nearly orbicular sepals with a four-parted corolla and four short stamens, the ovary being crowned with a four-lobed stigma. The fruit is red, and of the size of a peppercorn, containing four seeds enclosed in a slightly glutinous pulp, but often one seed only is developed. The home of the Paraguay tea plant is said by Martius to lie between 18° and 30° S. latitude, but the district in which the tree grows most luxuriantly is between 21° and 24° S. latitude in the watershed of the Paraguay river on the west, and in that of the Panana river on the east, and it is here in a zone between the Serra Amambuhy on the south, and the Serra Maracajú on the north, that the best and most highly prized mate is prepared.

How long the South American Indians had been in the habit of using mate is not known, but when the Spaniards seized the provinces on the rivers Paraguay and Uruguay they found this custom prevailing there exactly as first mentioned in the writings of Azara, who stated that the tree grew wild in different parts of Paraguay. In proof of the high estimation in which it was held by the Indians, it may be mentioned that the name "caa," which signifies in the Tupi language a tree or plant, was given by way of distinction to mate, that being the tree valued above all others. The use of mate does not appear, however, to have extended to extra-tropical districts, but to have been confined to the more intelligent tribes known now under the name of Guarani Indians. Nevertheless, when these people were driven further north by Europeans, they do not appear to have carried the use of the drug with them, probably thinking it not worth while to obtain it from a distance and from a hostile people, when they found a substitute close at hand in the Guarana plant.

The extensive use of mate in South America at the present time is probably due in great measure to the Jesuits, who encouraged its use, finding that it restrained the desire of the Indians for spirituous drinks, while its cultivation, collection, and preparation gave employment to converted Indians and brought wealth to the order. In the Jesuit Republic, the Indians were not paid in money but in produce; 4 lbs. of mate were allowed to each family.

After the expulsion of the Jesuits, the preparation of mate was continued in the Paraguay Republic under the administration of the Dictator Francia and his successors, until the Dictator Solano Lopes was killed in battle with the Brazilians in 1870. An overseer was appointed over the work who also was paid in kind, receiving for each aroba of the tea natural produce of the value of ⅛ ounce of gold. Since 1870 there has been free trade in the article, which renders an increase of the trade very desirable. At the present time mate is used by about 12,000 of people,

and the consumption amounts to about 8,000,000 pounds.

It has been stated that mate is not prepared solely from *I. paraguariensis*, St. Hil., but that the leaves of other species are mixed with it.

In 1842, Sir W. J. Hooker published, in the *London Journal of Botany* (vol. i., p. 30), an exhaustive account of the yerba mate, together with the characteristics of the different varieties which he considered identical with *Ilex paraguariensis*. This paper strengthened the previous opinion of Miers that probably more than one species was used in the preparation of the tea. The investigations made by Miers and the monk Leandro, Director of the Botanical Gardens in Rio Janeiro, confirmed by Bonpland, indicate that six different species are used for the purpose:—(1) *Ilex theezans*, Bonpl., growing in Paraguay, Entre Rios, and Brazil; (2) *Ilex ovalifolia*, growing in the neighbourhood of Rio Pardo; (3) *Ilex amara*, Bonpl., on the mountains of Santa Cruz, and in the forests of the Brazilian province of Parana; (4) *Ilex crepitans*, Bonpl., in the interior of Santa Cruz, and the banks of the Parana river; (5) *Ilex gigantea*, Bonpl., on the banks of the Parana river. This is the "caa-una" of the Guarinis. (6) *Ilex Humboldtiana*, Bonpl., in the province of Rio Grande do Sul. This is the "caa-unina" of the Brazilians. The last four species, more especially *I. amara*, yield the "caa-chira" of the Guaranis and the "caa-una" of the Brazilians. Martius, however, in the "Flora of Brazil," states that in the central districts of Paraguay, where the *I. paraguariensis* is especially abundant, only the leaves of this species are used; in other districts the various species of *Ilex* are similarly employed.

It is certain, however, that *I. paraguariensis* is the only species in cultivation, but this is carried on to a very limited extent as the wild plant is still abundant. The Jesuits planted the tree because they found that under cultivation the leaves had a milder and more pleasant taste. For cultivation the seeds are carefully freed by washing from the glutinous matter in which they are imbedded, without which treatment they would not germinate, this office being probably performed in a natural state by birds, since the Indians believe that the seeds will not germinate unless they have been voided by birds. The young plants are taken out of the hotbed when about six inches high, and planted out about twelve or fourteen feet apart, in a damp, somewhat marshy ground, so as to allow of a small trench being made around the plants in which water can collect. They must also be grown under the trees which afford shade, as the young plants are easily killed by a strong sun. When they are about three to six feet high, some of the shade plants are removed, and in four years the leaf harvest can be begun. The young trees should not, however, be entirely deprived of their leaves, lest they should not be able to recover. In the seventh year they will yield thirty to forty kilos of leaves. It is calculated that on 220 square metres of land one thousand six hundred trees can be grown, yielding on an averag thirty-five kilos of leaves per tree, or about 25,45 kilos of leaves, valued at 190,000 marks per 100 squar metres. The cultivated plant remains a small bush and never reaches the stature or size of the wild tree The cultivation of mate has been carried out witl much success in the province of Parana by Dr. E Westphalen, and it promises to be successful i the Dutch colony of S. Leopoldo in the provinc of Rio Grande do Sul, where the plant grow luxuriantly.

The tree has been planted in the Cape of Goo Hope and seems to succeed well there, as well as i Spain and Portugal. The quality of Paraguay te depends upon the time of year in which it is collected the leaves possessing most aroma when the fruit i nearly ripe. In the Argentine Republic, and in th Brazilian province of Rio Grande do Sul, the leave are collected from February to the end of July. Th new shoots are put forth in August, but at that tim it would ruin the trees to gather the leaves. In th forest of the Brazilian province of Parana and Sant Catherina the harvest is collected from March to th end of September. In Paraguay it begins in Decem ber and continues till August. About a montl beforehand the collectors set out in caravans witl their wives and children into the forests where th mate trees are abundaut, and make their encamp ment.

The first operation is to prepare a torrefier, whicl is made in the shape of an arbour. The twigs ar cut off from the branches and slightly scorched b drawing them quickly across the fire. The twigs ar then collected into bundles suspended over th torrefier, a small fire of dried wood being kept aligh beneath. In about two days the drying is completed the ashes are removed, and in the spot where the fir was an ox-hide is spread out, on which the leaves ar beaten from the twigs with a wooden blade. Th dried leaves are then powdered and packed in wooder cases made out of hollowed trunks of trees.

In the province of Parana the leaves have latel been dried in large wrought-iron pans, in the sam manner as Chinese tea, or in specially constructe ovens in which they can be prepared so as to retai more aroma; they are then powdered by machiner and sifted; this kind of mate obtains a better price.

Another form in which the leaves are prepared i by carefully separating them from the stalks an twigs and roasting them, but this is not so muc esteemed as the powder, except in Chili, where th leaves are prepared.

In the South American Republic and the Brazilia province of Rio Grande do Sul, mate is packed i serons of ox-hide holding thirty kilograms, and i half-serons, containing fifteen kilograms; this pack ing gives to the mate a disagreeable flavour, whicl detracts from its value.

In Parana it is packed in cane baskets; these ar lined with dried grass, called Jacaes, and contai fifty to sixty kilograms. The mate in leaves is her

sold at 280 to 290 reis (about fifty-six pence), powdered mate is sold in thick and better-woven cane baskets, containing in a half-seron, fifteen, and as a seron, sixty kilograms, the price being ten to twelve per cent. more than the leaves.

In the Spanish Republic three different sorts are sold under the following names:—

1st. Caá-cuy, or Caá-cuys; these are the new leaves of the scarcely developed shoots. They are of more delicate texture, and of a yellowish colour. They possess an agreeable and pleasant flavour, but are seldom met with in commerce.

2nd. Caá-mirim. This was the chief product in the time of the Jesuits, and consists of the leaves carefully separated from the twigs and stalks, the mid-rib of the leaf being also removed. This is kind chiefly esteemed in Peru, and principally exported there by the Brazilians. It is called Herva mansa.

3rd. Caá-guacu, or Caá-una, or Yerva de Palos, is the most inferior kind, consisting of the large and old leaves with the twigs and fragments of wood, and possessing a strong and bitter flavour.

In Rio Janeiro, two sorts are known to commerce, mate in leaf and mate in powder. In order to test the quality of mate, the merchant takes a small quantity in his hand and blows upon it. If the greater portion is blown away, he considers that it has been heated too much, and thus deprived of its strength. If it is not easily blown away, it is then considered of good quality.

Mate has been the subject of several analyses. In 1836, Trommsdorff analysed mate and found tannin, two resins, extractive matter, and a substance which he believed to be an alkaloid, but he possessed too little material for complete investigation.

In 1843, Stenhouse found in mate an alkaloid and proved that it was identical with caffein.

In 1850, Dr. Rochleder investigated Paraguay tea and found the reactions of mate-tannic acid to be identical with those of coffee-tannic acid.

Lenoble, who, as well as Dr. Rochleder, supposed mate to be produced by *Psoralea glandulosa*, named the crystal-line active principle he obtained from it, "psoralein." He also found in it wax, albumen, and volatile oil.

According to Dr. Byasson, mate contains as much caffein as the best Chinese tea. The variety which he experimented upon was caá-guacu. He found also a viscid substance resembling birdlime, soluble in ether; this he considered to be a fatty body of the nature of a compound ether whose alcohol was allied to cholesterine.

Robin has examined several different kind of mate. The amount of caffein in young leaves dried without special care was 0·02 to 0·03 per cent.

Mate prepared by the Indians, and containing twigs and fragments of fruit yielded 0·16 per cent., and mate from the Mission of the province of Corrientes, 0·14 per cent. The peculiar tannic acid, which Dr. Byasson did not find, varies between 1 per cent. and 1·6 per cent. The ash of young leaves varies from 0·12 to 0·2.

Professor A. W. Hofmann, of Berlin, found 0·3 per cent. of caffein. The average of the published analyses indicates about ½ per cent of caffein, that of India tea being 2 per cent. The value of mate, as in the case of tea, depends not merely upon the caffein but also upon the tannin and aromatic principles. He considered the tannin to be identical in every respect with that found in tea.

The aromatic principle has not been isolated, but by dry distillation a volatile oil is obtained, which belongs to the phenol group and is soluble in alcohol.

In 1877 the mate-tannic acid was examined by Dr. Pedro N. Arata, who found that the tannin of mate, while analogous to that of coffee, was not identical. The chief differences noticed by him are as follows:—Lime water gives with the coffee-tannic acid a small precipitate soluble in excess, but an abundant insoluble precipitate with the tannin of mate. This, however, does not hold good with all samples of mate, the precipitate being sometimes soluble in an excess of the tannin. Coffee-tannic acid gives by dry distillation pyrocatechin, while the tannin of mate yields in addition to pyrocatechin the isomeric body resorcin.

Coffee-tannic acid is soluble in 52·84 vol. of alcohol, while mate-tannic acid requires 73·66 vol.

Dr. Arata considers that coffee-tannic acid may be regarded as dioxyparacinnamylic acid, whilst mate-tannic acid must be classed in the group of oxy-phenylpropionic acid.

Soubeiran and Delondre state that mate contains the same essential constituents as the coffee leaf, and in greater amount than the coffee seeds, which Dr. Peckott confirms after numerous experiments with large and small quantities.

PARCELS POST.

If at present 20,000 or more parcels are daily posted in London, we may feel certain that such numbers will be multiplied many times over in the course of a few years; but we doubt if even in St. Martin's-le-Grand they would venture to predict how many times. The gradual development of the existing parcel-carrying business was foreseen; its gradual deflection from hitherto recognised channels; as well that it would in course of time raise up for itself new developments of retail trading that at present can hardly be said to exist at all. The Post-office authorities based their estimates upon a traffic very similar to that they have received. Still, to be forearmed against all mishaps, it was necessary to have a large margin of available resources, and this was provided. Everything has worked smoothly, and without high-pressure, sufficiently long for the new machinery to become settled in all its bearings; and there are no longer any fears of an excessive strain being thrown upon the new department this side

Christmas-week. A steady increase in the numbers of parcels to be carried will have to be faced. Indeed, as it stands, the department is well able to cope with such an increase; and if, on some of the days before Christmas, there should be half-a-million parcels posted within the London area, they will, we venture to predict, be dealt with without any undue delay. On such occasions it will be to the advantage of both the public and the Post-office if senders of parcels are instructed to post them early in the day, more especially shopkeepers who may have the execution of orders for large numbers of Christmas presents. But it is to be remarked that the rumours current before the 1st of August, that many manufacturers and shopkeepers would seize the opportunity to advertise themselves and their wares by sending out large masses of parcels, have hitherto in the main been falsified. Such people have waited to see how the parcels-post has worked before testing it in this manner.

It is interesting to note the sizes, shapes, weights, and descriptions of merchandise at present entrusted to the Post-office. Naturally, parcels posted in the metropolis or other large towns differ a good deal in shape and contents from those coming to town from the country. From London, parcels of books, samples of drapery materials, clothing, and smaller metal wares, make up into handy and compact packages not difficult to post, and it is found that their average weight is something under 3 lbs., the average postage being under the 6d. rate, or about 5½d. per package. From country districts the goods are somewhat more unwieldly, and are heavier on the average; but still the ideal 7 lb. parcel, which is of the maximum length of 3 ft. 6 in., with a girth of 2 ft. 6in., is only conspicuous by its absence.

The complaints we hear are altogether surprisingly few. Still, it would be impossible to effect so great a change without complainings, and where there are details which may be adjusted to the convenience of the public, it is right they should be so adjusted. In the first place, in respect to small parcels, it is complained that the sender of a parcel weighing under ½ lb. must still pay 3d., which is the charge for 1 lb., unless the parcel should be a book packet, when ½ lb. will go for 2d., and ¼ lb. for 1d. It is true that a parcel weighing ¼ lb. can now be sent by letter-post for 2d.; but it is worthy of consideration whether hereafter the rates for book-postage and parcel-postage may not be advantageously unified, or better still, the two amalgamated altogether. In that case, a ½ lb. parcel would be charged 2d., and a ¼ lb. 1d. While this much may be said in the interest of the small parcel, there is also a good deal to be urged in the favour of the larger one. The time will probably come when the 7 lb. limit now imposed will have to be expanded without increasing the maximum dimensions now permitted. Twelve or fourteen pounds would cover a large mass of goods now excluded from the advantages of the parcel-post, and with the machinery for collection and delivery in working order, it is less weight than bulk that the Post-office has to contend against. Probably the small parcel would even then considerably outnumber the large ones; but as it is, we look to the average weigh of parcels gradually increasing as packing difficulties come to be more readily surmounted. Whethe in course of time the bulk of the collection and delivery of parcels may not with advantage be entrusted by the railway companies to the Post-office is also a point which will probably arise for future discussion. The railway companies would thereby be enabled to effect important savings, and at anything like their present 55 per cent. of gross receipts they would receive a handsome remuneration for their share of the joint business. That some jealousy of the postal arrangements should at present be manifested is natural enough, but it will soon vanish as it is found the railway interests are identical with those of the Post-office. On some other points it is necessary to touch. Facilities for registration will admittedly have to be afforded within a comparatively short time; for at present, articles of value requiring insurance cannot be entrusted to the parcel-post, for want of the necessary voucher and safeguard which registration affords. It also is very desirable that the times of clearance for parcels-postage should be made known to the public generally through the local press and by other means, that needless delays in transmission may be avoided.—*Economist.*

POPULATION AND EDUCATION IN HUNGARY.

H.M. Secretary of Legation at Pesth reports that, according to the census taken on the 31st December, 1880, of which the full details have only recently been published, the population of Hungary, and the territories belonging to it, was as follows:—Hungary proper with Transylvania, 13,728,622; Fiume and territory, 20,981; and Croatia, Slavonia, with military frontier, 1,892,575—in all, 15,642,178. The increase of population, compared with the census taken in 1870, amounts to only 224,851, or 1·46 per cent. The causes of this slow increase is attributable, firstly, to the cholera which raged in the period 1872-3; this is estimated to have carried off 450,000 persons, and its effects were felt until the year 1877. There has also been a very great mortality among children, the statistics of death in Hungary having proved that 52·3 per cent. of the deceased males, and 48·9 per cent. of the females, had not completed their fifth year. The question in the census papers as to the "mother tongue" exhibited the following results:—Hungarians, 6,165,088; Germans, 1,798,373; Slovachs, 1,790,476; Roumanians or Wallachs, 2,323,788; Croats and Serfs, 605,725; Ruthenians, 342,351; the remainder being principally made up of foreigners and *Zigeuner* or gipsies. In answer to a question

it in the census paper to inhabitants of alien nationalities, in order to ascertain the number of persons speaking Hungarian in addition to their ien mother tongue, it appears that 21 per cent. of he Germans admitted to a knowledge of Hungarian, nd that only 11·5 per cent. of all the persons eclaring themselves to be foreigners were acquainted ith the language of the State. In the city of Buda-esth itself, 55·12 per cent. of the inhabitants eclared Hungarian to be their mother tongue, and 3·25 per cent. German. The various religions are hus divided:—Of the 7,500,000 Roman Catholics 3 per cent. are Hungarians, 18 per cent. Germans, 9 per cent. Slovachs, and 2·5 per cent. Croats, &c.; of the Evangelical Augsburg Confession 1,100,000), 23 per cent. Hungarians, 34 per cent. Germans, and 38 per cent. Slovachs; of the Reformed Protestant Church (2,000,000), 94 per ent. are Hungarians. The Unitarians (55,000) are xclusively Hungarians; and of the Jews (600,000), 6 per cent. declare themselves to be Hungarians, nd 33 per cent. Germans. It is estimated that 7,432,800 persons, or 53·5 per cent. of the entire opulation, either acknowledge the Magyar anguage as their mother tongue, or are acquainted with it. It appears that, in 1850, there were only nine Hungarian papers or periodicals; while, in 1880, there were 368, and, in 1882, no less than 412, of which 21 are daily papers. The number of periodi-cals in the German language, in the year 1882, is stated to be 104, and, in other languages, 70. The population of Buda-Pesth was, in 1870, 280,249; in 1881, it was found to amount to 370,767, thus showing an increase of 32·11 per cent., and an annual average increase of 2·9 per cent. It now ranks as the thirteenth among continental European towns in point of population; whereas, in 1870, it was twenty-third on the list. The rapid increase in the population of the capital is not attributable to the establishment of resident families, but to a constant influx of working people in search of employment. Thus, although the population has increased by 70,000 between 1874 and 1881, the number of births, which in the former year was 13,194, amounted in 1881 to 13,193. In 1876, for every 1,000 inhabitants, there were 45·8 births; in 1881, only 34·9. Statistics of births have shown that 32·20 per cent. of the total births are illegitimate, and that to every 1,000 births there are, on an average, 73 stillborn children. It is also noticeable that the number of females in the capital exceeds that of the males by 7 per cent. Mortality in Hungary has assumed gigantic proportions. In 1876, the number of deaths was 478,684, and in 1880 it was 529,213. According to Mr. Phipps, this mortality is mainly attributed to the indifference exhibited as regards human life, and defective sanitary arrangements. The sanitary laws, though carefully drawn up, are almost a dead letter. Out of 1,132 sanitary districts into which the country is divided, it was found that in the year 1878, the latest year for which trustworthy information is published, in 489 of these districts there were no medical men. Even when doctors are to be found, it is stated that they are not able to be of much service, as the lower classes are described as being afraid of doctors, and the medical men are so entirely dependent on the communal authorities, that they are powerless to exert the requisite energy for carrying out sanitary measures. As regards the education of the people, there are at present 15,922 lower or elementary schools, of which 318 are State, 1,686 communal, and 13,745 confessional schools. In about half of these the language of instruction is Hungarian, but only from the fact of Hungarian-speaking people forming the majority of the population in the districts in which they are situated, for it is only in the 318 State schools that the Government exercises any control over the language in which instruction is to be given. A certain amount of instruction in the Hungarian language is, however, prescribed in all public schools, and all professors and teachers are forced to be acquainted with it as the language of the State. In Hungary, the composition of the population of the district decides what is to be the language of instruction. Out of 2,119,676 children, properly subject to compulsory education, 1,656,337 habitually attend schools. The *volkschule*, or lower schools, have increased since 1870 by 14·7 per cent., and there is now one to 867 inhabitants. Of the middle-class schools, 24 are State, and 151 confessional; and of the whole number, 87 are more or less under Government control. Croatia has its own educational organisation, entirely independent of the Hungarian State.

THAMES POLLUTION.

The Annual Report of the Thames Conservancy for the year 1882 (ordered by the House of Commons to be printed, July 16) is now issued. The reason that the presentation of the report is always delayed till this time of the year is, that time is required for the accounts, of which a balance-sheet has to be rendered. The report deals principally with the repairs of locks and bridges, and the regulation of careless navigation. With reference to the prevention of pollution, there are but two short paragraphs. One refers to the constant supervision over effluent sewage into the Thames itself, and into all tributaries for ten miles each side of the main stream, in accordance with the powers granted by the Act of 1878; and the other refers to the maintenance of all work in such a state of efficiency that, above the intakes of the water companies, the river is free from sewage contamination.

Nothing is said of any plans with regard to the sewage which still flows into the Thames between Chiswick and the intakes, though last year's report contained the following passage:—"In the district between the intakes of the water companies and the western boundary of the metropolis near Chiswick

sewage still passes into the river; the penalties of the river being suspended, for the present, by an Act of Parliament. The conservators hope that before September, 1883, the date when this Act expires, some scheme may be devised for diverting from the river the sewage of Kingston, Richmond, and other places in the lower Thames valley district."

In *Ashore or Afloat*, for August 17, "Stephanotis" has raised a question of practical importance with regard to river pollution and fish. He points out that it is "the fashion" to speak of river pollution as the cause of the depopulation of our streams' not only here, but on the Continent. He says, "I purposely say the fashion, for I cannot find the idea rests on evidence." His argument is that the depopulation and the pollution may be only coincident, and that the depopulation may be really due to other causes.

Though no suggestion is made here as to what these other causes may be, it has often been mentioned that increasing navigation has much to do with the interference of breeding.

The practical point "Stephanotis" suggests is this:—"If, as it is the fashion to believe, it is sewage-pollution alone that is destroying fish, then with the Thames brought back to freedom from sewage the fish ought to be returning. If it is shown they do not return, other reasons must be sought, and freedom from sewage must not be relied on for bringing back our fish." . . . . "There is no place where the question can be so well put to the test of proof as in the Thames." The collected experience of anglers, whose notes and recollections run back for twenty years, would, he argues, be most valuable evidence in helping to set this important question at rest.

INQUESTS ON FIRES.

The following letter from Lord Alfred S. Churchill appeared in the *Times*, of August 23rd:—

SIR,—In the *Times* of this morning I observe, under the heading of "The Fire at Southall Lunatic Asylum," that Dr. Diplock, the coroner for the county, has declined to hold an inquest upon the calcined bones found in the ruins after the calamitous fire which recently occurred at that institution, although it was known that four persons lost their lives.

In the course of the present season a public meeting was held at the Society of Arts to discuss the report of a committee appointed to consider the prevention of fires in theatres, when one of the resolutions passed was to the following effect:—"In all cases where serious loss of property has occurred through fire, provision ought to be made for holding an official inquiry by some competent authority." This resolution was forwarded to the Home Secretary.

I am glad to see that this point of view is obtaining notice in other quarters, and that the Chamber of Commerce of Halifax proposes to bring before the meeting of the Association of Chambers of Commerce at Derby in October next a resolution to the effect—"That in consequence of the numerous fires that have occurred in recent years, involving enormous losses, and consequent onerous rates of insurance, this association hereby records its opinion that it is desirable that official inquiries should be made into the cause and extent of such fires, and resolves that a memorial be presented to the President of the Board of Trade, requesting him to introduce a Bill making it imperative that an inquiry be held by such official as Parliament may decide upon, into the origin of every fire, which may be brought under the notice of the police, and which may be considered worthy of investigation, or to which the attention of the authorities may be directed by any interested party."

Surely the numerous calamitous fires which have recently occurred, whether attended with loss of life or otherwise, demand an official examination into their causes. It is to be hoped that Her Majesty's Government will turn their serious attention in this direction.—I am, Sir, your obedient servant,

ALFRED S. CHURCHILL.

General Notes.

GOVERNMENT PATENT BILL.—The Patents for Inventions Bill was read a third time in the House of Lords, and sent down to the Commons on Wednesday, August 21. The Lords' amendments fill seven pages of print, but they are mostly of a verbal character, and do not affect the main principles of the Bill.

SUBMARINE EXPLORATION.—Signor Toselli is reported to have invented an apparatus for exploring the depths of the ocean without danger or inconvenience. It is about 25 feet in height, and constructed of steel plate with gun-metal castings. It is calculated to resist a pressure of 180 lbs. to the square inch, so as to be able to attain a depth of 65 fathoms. The internal space is divided into three compartments—at the bottom, a chamber capable of being enlarged or contracted by a flexible diaphragm, so as to increase or diminish the volume of water displaced, and thus permit of rising or sinking; a room capable of holding eight explorers, occupying the central portion of the spheroid, and provided with lenses, so as to permit of looking out; and the upper space, reserved for those entrusted with manœuvring the vessel. A powerful electric lamp is to shed its rays all round the apparatus for a considerable area, and telegraphic and telephonic wires will place those in the vessel in communication with the steamer from which it is suspended.

Journal of the Society of Arts.

No. 1,606. Vol. XXXII.

FRIDAY, AUGUST 31, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

"OWEN JONES" PRIZES, 1883.

This competition was instituted in 1878, by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of the subscriptions to that fund, upon trust to expend the interest thereof in prizes to "Students of the Schools of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers, and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design" and a Bronze Medal.

The following is a list of the successful candidates:—

1. William H. Woodall, West London School of Art.—Design for Tiles.
2. Thomas Barrett, School of Art, Macclesfield.—Design for Silk Hangings.
3. James Fletcher, School of Art, Glasgow.—Designs for Carpets.
4. J. G. Jeffrey, School of Art, Coalbrookdale.—Design for an Italian Majolica Drug Pot.
5. Thomas J. Donohue, School of Art, Macclesfield.—Design for an Embroidered Silk Cover.
6. Constantine Procopides, School of Art, Cavendish-street, Manchester.—Design for Surface Printing.

Proceedings of the Society

CANTOR LECTURES.

THE DECORATIVE TREATMENT OF METAL IN ARCHITECTURE.

By George H. Birch.

Lecture I.—Monday, April 2nd, 1883.

THESIS.

Architecture has been well defined by Riechensperger as an "aggregate of various beautiful arts, working principally by means of proportion." Sculpture and painting, of course, take the first rank in this aggregate, and although it may be possible to produce a building absolutely void of either one or the other, and depending entirely on architecture—that is, the science not only of construction, but also the art of proportion, or what the Greeks called συμμετρία—no one would for an instant debar the use of any of the subsidiary arts, in order to enhance or set forth more advantageously such a building. And the more successful will this building be, and the more satisfying and pleasant to the eye, when these subsidiary arts are kept in due subordination to the leading architectural features, and accentuate rather than destroy their harmony of proportion. This maxim is equally true of all styles of architecture, whether they be of remote races, like the Egyptian or Assyrian, or the more refined or pure forms of Greek, Roman, Byzantine, or Mediæval. We must admit these subsidiary arts as a necessity, for our noblest endeavours in architecture without them would be cold and lifeless, and would never satisfy the ever busy and inventive mind of man, who, through the countless ages, has ever appreciated and yearned for the embodiment of that ideal of perfection for which he strives, and which he hopes yet to attain.

Sculpture and painting are the two prominent arts, but there is also another one, subsidiary, but no less prominent, and that is the employment of the metals. It is of equal antiquity, and dates from a period so remote, that there is scarcely a style of architecture now known to us, both from accurate descriptions of ancient authors or modern research, in which we do not find it more or less apparent.

The first metals with which we have to do

are the precious ones, gold and silver, and the first nation to whom one would naturally look for examples of the use would be Egypt, that mysterious land, with an antiquity so remote that, not withstandingthe flood of light which has been thrown upon its early records by the fortunate discovery of the key to its hieroglyphics, our knowledge of the earlier dynasties is but slight and superficial, a knowledge which I believe to be only on the threshold of the door through which we are yet to see the dim vista of departed ages. The slab of Hatharsa, of the 12th dynasty, describes that he "compelled chiefs to wash gold;" and the tablet of Nebuaiu, in the reign of Ramenkheper ("Thothmes" III.), more particularly sets forth that, as High Priest of Osiris, "I dedicated numerous works in the house of my father Osiris, of silver and gold—I was called to the house of gold;"* thus clearly setting forth that this metal formed an important part of the architectural decoration. Egyptian architecture, in these days, shows but little trace of any metallic adornment, nor was its use at any time so prevalent as with the Assyrian, Chaldee, Babylonian, Medo-Persian and other Semitic races. Gilding was applied, not such as we understand it now, when the metal is beaten and applied in an infinitesimal manner; the ancient leaf gold was much thicker. An inspection of some of the mummy cases, both at the British Museum and the Louvre, will give an idea of what the Egyptians called gilding. The material of which some of their stupendous temples were built, as Karnak, Luxor, Abydos, and Medinet Habou, being either a fine limestone or granite, the same necessity did not arise as in the Valley of the Euphrates, o covering up an inferior material, such as sur dried bricks, with costly sculptured slabs. I Egypt, sculpture and painting were profusel applied to the exclusion of other forms o decoration; but we know that many of thos very beautiful monolithic columns, calle obelisks, were decorated with gold; both th pyramidion and the base were sometimes eithe gilded or covered with metal plates, and wer often surmounted by a golden disc; and gol must indeed have been very plentiful among them, if the Children of Israel could borrow t the extent that they afterwards did. The gol mines of Midian were very extensively worke by the Egyptians. Captain Burton has dis covered the cartouche of Rameses III. in som of the disused workings, and the cartouche o a much earlier king, Kheperkara, or Usertesen in the Sinaitic peninsula.

The great Assyrian empire—an empire ol even in the days of Abraham, and whose swa once extended over the whole of Wester Asia—was remarkable for its use of th precious metals as architectural adornments Babylon and Nineveh, two of the mighties cities of the old world, whose very existenc had been questioned, as their sites had bee forgotten, contribute, by the mute evidence c their sculptural inscriptions, in a characte once as mysterious as the Egyptian, to th truth of many of the statements made by tha wonder-loving Greek, Herodotus of Hali carnassus. One of these stories was that th temple that Nebuchadnezzar built at Borsippa and which consisted of several storeys, diminish ing in size and superimposed, the outer wall of two of these being covered with gold an silver plates respectively; and that a Agbatana, the capital of the Medo-Persia empire, the palace of the king, which ha wooden beams, ceilings, and pillars, wa covered with plates of gold and silver, an was roofed with silver tiles. There seems t be a possibility of truth in the latter state ment, for Polybius, who may be accepted as more sober adherent of actual truth tha Herodotus, confirms this (Book x. chap. 27) Darius, when retreating before Alexande took gold away from Agbatana to the amoun of 7,000 talents; and yet, in the time c Antiochus the Great, sufficient remained t afford another 4,000 talents' worth of loo This palace was at the foot of the citade and about seven furlongs in circumference.

The temple at Babylon, which Herodotu calls the temple of Jupiter Belus, seems also t

* "I made to thee a secret chapel of stone . . . . the bolts on it of brass, covered with gold."—("Records of the Past," vol. vi., 54.) "I built a house for thy son, Khonsu, in Thebes, of good hewn stone, of sandstone, and black basalt. I plated its folding doors of the gate with gold, and overlaid it with electrum, like the horizon of heaven."—("Records of the Past," vol. vi., 32.) "I made for thee great tablets plated with good gold, with coverings of precious stones, the great board hinge of silver having coverings of gold touching the floor. I built for thee thy divine abode in the midst of the area . . . . its doors and its lintels were of gold, nailed together by brass; I inlaid it with precious stones like the bolts of heaven; I put gold on the two fronts of the temple, gold to the value of . . . ."—("Records of the Past," vol. vi., 33.) Stele, of Horsiatef, 27th dynasty, speaks of doors and lintels of gold.—("Annals of Rameses," iii.) I built its walls of carved stone, having great columns of good gold—the hinges and gates of gold, the great cornices crowned of pure gold, built with carved stone, sandstone, and black stone, with lintels of gold and brass. Great Harris Papyrus speaks of windows with shutters of cedar, plated with brass, having folding gates of brass of six sides—"I made for thee a new palace, its doors of brass of six bands, the great columns are of gold, the bolts of black metal."—(Harris Papyrus.)

ave been richly decorated; but the historian s careful enough to guard himself from any xaggeration, by stating that he had heard om the Chaldeans that the statue of the od and the throne and altars were all of olid gold, but that he himself had not seen hem, and that they were worth 800 talents. he Scriptures mention the golden image vhich Nebuchadnezzar the king set up. he discoveries at Nineveh, Khorsabad, Koyunjik, have brought to light the plan and rrangement of the palaces of several enerations of the monarchs of the Assyrian mpire; and the British Museum contains he wonderful sculptural slabs and colossal vinged bulls and genii, which lined and dorned the various apartments of these ruly regal halls. In imagination, we can nce more conjure up the splendid vision of heir pristine magnificence; the walls glowing vith sculpture and colour, and built, or rather ined, with costly alabaster; the gilded ceilings, he battles and triumphs, the huntings, and easts, and religious festivals of the Shalmanasers, Assurbanipals, Sargons, Sennacheribs, Esarhaddons, and Sardanapalus, names so familiar to us now, not only from the handwritings on the walls of their palaces, but from their deeds, their conquests, and reverses, so graphically described in the Bible. "The solemn temples, the gorgeous palaces" have passed away, and left but ruined heaps and grass grown mounds behind. "Babylon the mighty is fallen. Babylon the glory of nations shall never be inhabited; the wandering Arab shall not pitch his tent, nor the shepherd lead his fold. The wild beasts shall howl in her pleasant palaces. The golden city hath ceased."

Contemporary with this mighty Assyrian empire, and finally absorbed into it, is the kingdom of Israel; and here we have no occasion to trust to the hearsay evidence of a polished Greek. We know from the Bible itself the extensive use that this purely Semitic race made of the precious metals, when it is recorded that, in the time of Solomon, gold was nothing accounted of, and silver in Jerusalem was as the stones of the streets.

It would be tedious to recount how, even from the time that the children of Israel were journeying in the wilderness before they had become settled in the Land of Promise, they had employed some of the precious metals which they had borrowed, in making the sockets, and rings, and capitals of the columns, for the Tabernacle, and how the columns were overlaid with pure gold, which I myself should consider as a slightly hyperbolical way of describing plain gilding, excepting, of course, the candlestick and lamps, and altar of incense, which were of pure gold, and according unto the pattern shown to Moses on the mount. Four hundred and eighty years afterwards, when all the neighbouring and hostile nations had been successively subdued or utterly annihilated, and they had become a rich and powerful nation under David, Solomon, his son and successor, 1,015 years before Christ, began the building of that wonderful Temple, wonderful not for its size, for it was far surpassed both in size and magnificence by the temples of contemporary nations, and in beauty by succeeding ones—Thebes and Memphis, the Parthenon and Ephesian temple, all erected to false gods; but it was wonderful as being the only building of a true and pure faith, the embodiment of the religion of the Most High, and in which a chosen nation's hopes and aspirations were inseparably centred, and will be for all time.

Although we know that the walls were of hewn stones, great and costly, its chief embellishments were principally metallic, and consisted of the precious metals, although bronze, to which I shall have again to allude, was extensively used. As to its form and fashion, it matters but little whether it resembled Persian or Egyptian examples; volumes have been written, and authorities have wrangled over it for ages. One modern manufacturer of mediæval metal work has attempted to prove that it was entirely made of metal, and that no stone was used except for foundations, and bases his belief on one particular verse in the 1st book of Kings, which states that there was neither hammer nor axe, nor any tool of iron heard in the house when it was building, so that all the parts must have been put together with screws; rivets would have been impossible under the circumstances. One might equally as well start the theory that it was entirely of cedar or other wood, and quote the same chapter as an authority, "as there was no stone seen."*

Josephus' description of the temple, although mainly derived from the same source, the description in the 1st book of Kings, is so far interesting as it is interwoven with other traditions, which doubtless had been handed down from generation to generation among the Jews; and even allowing for that love of hyperbole, so natural to Eastern nations,

* Josephus, de Antiq., Liber. viii., Cap. 3.

and pardonable in Josephus, who was compiling a history of his own race, and was naturally anxious to represent them in the best light to the Roman conquerors, this temple of Solomon must, indeed, have been truly resplendent, and a matter for wonder and admiration, not only with the Jews, but among neighbouring nations, and, perhaps, also a matter of cupidity, for a very few years afterwards, in the reign of Solomon's son and successor, Rehoboam, Shishank, called Shishak in the Bible, king of Egypt, marched against Jerusalem, and spoiled the temple, emptying it of its treasures, and carried off an immense booty of gold and silver, leaving nothing behind.

The description of the palace which Solomon built gives a very accurate idea of the splendour with which these Oriental monarchs surrounded themselves, and is a correct representation of those palaces which Sir Henry Layard has unearthed at Nineveh and Khorsabad, even to the sculptured lining slabs and ivory throne. The description says that it was entirely built of white stone, cedar wood, and gold and silver; the roofs and walls were resplendent with gold. In the Biblical account, mention is made of Hiram, King of Tyre, who assisted Solomon especially in making the metal ornaments, for the Jews appear to have had but very little aptitude that way. Hiram's name has been handed down to us from another source. Josephus alludes to Menander's account of both him and his father, how he dedicated a golden pillar in the temple of Jupiter at Tyre, and rebuilt the temples of Hercules and Astarte. These Tyrians are supposed by some to be those mysterious Phœnicians who had many settlements on the different shores of the Mediterranean, and whose ships traded to all parts of the known world, even to the shores of the distant Cassiterides or Tin Islands, supposed to be either Scilly or the Cornish coast.

Leaving the sacred writings, the next epoch to which I must direct your attention is one which is invested with such a peculiar charm of its own, that, even now, the greatest minds of the age are as equally fascinated with it as the ancients were over 2,000 years ago—and that is the Homeric age.

We cannot fix, with any amount of certainty, the precise period when Homer, the blind poet of Smyrna, wrote those wonderful epic poems of the "Iliad" and "Odyssey." It is generally supposed that he lived about 168 years after the siege of Troy, or, roughly speaking, 1,100 years before our era. In language almost sublime, and exercising the same soul-stirring effect that some portions of Shakespeare exercises upon English-speaking people, both in the old and new world, he describes palaces and buildings such as he himself must have seen or heard of, and not evolved alone from his poetic fancy. He gives us no idea of the peculiar style of the architecture, but dwells upon the golden doors and the silver ornaments; and whether it is the palace of Alcinous, or the halls of the Spartan Menelaus, he graphically describes, in glowing verses, such a wealth of metallic splendour that, to borrow a phrase of his own, "they pour along like a fire that sweeps the whole earth before it."

Although the description of the palace of Alcinous has become almost hackneyed from the frequency with which it has been quoted, I do not think that any account of a decorative treatment of metal work in architecture, such as I am now endeavouring to put together, would be complete without it. I must trust, therefore, to your leniency:—

"Meanwhile Ulysses at the palace waits,
There stops, and anxious with his soul debates,
Fixed in amaze before the royal gates.
The front appeared with radiant splendours gay,
Bright as the lamp of night or orb of day.
The walls were massy brass; the cornice high,
Blue metals crowned, in colours of the sky;
Rich plates of gold the folding doors incase,
The pillars silver, on a brazen base;
Silver the lintels deep projecting o'er,
And gold the ringlets that command the door;
Two rows of stately dogs on either hand,
In sculptured gold and laboured silver stand;
These Vulcan formed with art divine, to wait
Immortal guardians at Alcinous' gate.
* * * * *
Refulgent pedestals the walls surround,
Which boys of gold with flaming torches crowned;
The polished ore, reflecting every ray,
Blazed on the banquets with a double ray."

And again, when Telemachus and Pisistratus arrive at Sparta, and are hospitably entertained by Menelaus:—

"Then to the dome the friendly pair invite,
Who eye the dazzling roofs with vast delight,
Resplendent as the blaze of summer noon,
Or the pale radiance of the midnight moon.
* * * * *
High on a massy vase of silver mould
The burnished laver flames with solid gold,
In solid gold the purple vintage flows.
* * * * *
View'st thou unmoved, O ever honored most!
These prodigies of art and wondrous cost?
Above, beneath, around the palace shines
The sunless treasure of exhausted mines."

On reading such lines as these, is it to be supposed that this is all poetical imagination? Is it not borne out fully by Solomon's contem-

porary work at Jerusalem, and Herodotus's account of Nineveh, Babylon, and Agbatana?

You know that doubts have been thrown on the probability of the existence of these Homeric heroes, but does not Dr. Schlieman's wonderful discoveries at Mycenæ, Orchomenos, and at Hissarlik, rather confirm the fact of their existence? Agamemnon, king of men, and Ulysses, are no longer myths; the discovery of the tombs, and the immense amount of gold buried with these ancient heroes, is a silent but striking testimony that in those early days they were possessed of gold and silver, and were in the habit of using these metals in the decoration of their buildings, far beyond what we had given them credit for, and strongly corroborating the grand descriptions of the blind old poet; and, in a lesser degree, we find the same in the tombs of the primitive inhabitants of Italy, the Etruscans pointing to a common origin, perhaps Pelasgic. But one fact is important to remember, and that is, "gold must have been accounted of" for almost nothing if they could have buried it as they did in such immense quantities in the numerous tombs of this period, and although, as in Italy, these tombs have been quarried for ages in search of treasure, quantities yet remain to continually swell the contents of the museums of Europe.

Transporting oneself back to Athens, the violet crowned, and standing before that wondrously beautiful Temple of Pallas Athene, which crowned the Acropolis, exquisite in every line, breathing a refinement so subtle, and exhibiting a harmony of proportion so perfect that it seems the very embodiment of the intellectuality of ancient Greece, now scarred and riven by violence, naked and open to the deep blue sky of Hellas with its sublime sculpture torn from its place, its colonades broken, and pediments shattered, and yet still sublimely beautiful. Could there possibly have been room for any decoration beyond the perfect symmetry of its own faultless proportions, or the polished purity of its Pentelic marble? The answer is "Yes;" not only was colour applied—those almost breathing forms from the hands of Phidias, now in the British Museum, clearly show that beyond all dispute—but metallic decoration also lent its aid in adding to a beauty perfect in itself. On the Parthenon are still visible the holes for clamps in the architrave, and circular stains upon the marble, showing that under each of the metopes was suspended a gilded shield; and smaller holes under the triglyphs indicate that inscriptions in raised gilded letters formerly existed between each.* It is supposed that these indicate the votive offerings of shields which Alexander gave to the Parthenon, and which he had taken from the Persians after the battle of the Graneicus; but I cannot help thinking myself that they form part of the original design. The acroteria or small winged gryphons which decorated the corners and summits of the pediments were also of gilded metal; and again, the railways or grilles between the columns and the antæ, of which traces are found, and which closed the porcoes, were also gilded; and passing into the interior, the first object which must have struck the beholder when entering the cell was that *chef d'œuvre* of Phidias, the chryselephantine statue of Pallas Athene,† glittering with golden raiment and crested helm, contrasting with the soft creamy beauty of ivory flesh? And what was true of the Parthenon was also true of the temples of Jupiter at Olympia, of Apollo at Delphi; both of these temples were full to overflowing with the votive offerings of generations; and when Herod re-built the temple at Jerusalem, we hear from Josephus, that the sacred inner sanctuary was decorated with a golden vine; and in that fearfully graphic account of its final destruction under Titus Vespasianus, how the Roman soldiers set fire to the doors of the inner porches, and the silver plates wherewith they were covered being molten, the flames quickly fired the wood and communicated with the interior; and although Titus endeavoured to save the building, the

* Pausanias ("Attica," xxv.)—That when Demetrius Poliorutes succeeded in driving the tyrant Lachares from Athens, the latter carried off with him whatever golden ornaments he could from the statue of Pallas, and also the golden shields.

† Monsieur Quatremère de Quincey, who has devoted considerable attention to these chryselephantine colossal statues, considers that the groundwork was entirely of wood, and those portions of the figure which represented flesh were incrusted with ivory. That this was evidently the case there is but little doubt, as precautions were taken to prevent the swelling or shrinking of the wood, or the opening of the ivory joints, by sprinkling it with water, on account of the dryness of the atmosphere; while at Olympia the opposite course had to be pursued, as the temple there was at the foot of a high hill covered with dense groves of trees, and the damp arising therefrom being likely to injure the statue of Jupiter, it was constantly well rubbed with oil. The drapery of both these statues was covered with gold plates, that of Minerva was supposed to be of the amount of from forty to fifty talents, and the ornaments supposed to have been carried away by Lachares had either been restored or replaced, as Pausanias, who saw it A.D. 170, still describes it as of ivory and gold. Menon, one of the pupils of Phidias, accused his master of not having used all the gold given by Pericles for the purpose; this base accusation was triumphantly refuted by Phidias taking off all the gold and having it weighed, when it was found to correspond exactly.

mad fury of his legions carried everything before it, until at last the golden gates of the inner sanctuary were consumed, and the whole building utterly destroyed. Such was the immense booty carried off by the Roman soldiers that they sold gold in Syria for half its value.

All the portable treasures we know were carried to Rome, and after gracing the triumph of Vespasian and Titus Vespasianus, were finally deposited in the Temple of Peace erected by them, and the triumphal arch of Titus to this day commemorates the event, and in its sculptures are seen the golden candlestick and table of shewbread.

Leaving Athens for Rome—the Imperial City, the mistress of the known world, into whose lap nations had poured the accumulated treasures of long centuries—one is almost bewildered by the many examples of the employment of the precious metals in the architectural adornment of its magnificent edifices. We scarcely require the evidence of Plutarch and Livy, of Pliny, Aulus Gellius, and Marcellinus, as to the golden house of Nero, the gilded Capitol, the temple of Ceres, the gilded statues and trophies of the Ulphian Basilica, or Forum of Trajan. Ovid, in the "Fasti," book i., verse 76, in addressing Janus, speaks of the "flame kindled on the altars [which] with its brightness irradiates the gold of the temples;" and again in book vi. verse 70, he puts these words in the mouth of Hebe, "My mother, that is Juno, has gained possession of the Capitol glittering with gold;" and when we reflect how little the Romans respected the temples of other nations, how they plundered Athens under Sylla, and Corinth under Mummius, it is not surprising that their own buildings were decorated with the stolen treasures of gold and silver; but the marble statues of the gods, the masterpieces of Phidias, Praxiteles and Lysippus also adorned their sanctuaries.

After the Imperial city was deserted by its Cæsars, and a new Rome rose on the banks of the Bosphorus, and Christianity had nearly displaced the effete and worn-out mythology of the Old World, the same traditions, as to the use of the precious metals, were as applicable to the gorgeous domes erected by Justinian at Byzantium as they had been on the Capitoline hill of the Eternal City. The church of Santa Sophia, or Holy Wisdom, beautiful even now in spite of its horrible desecration at the hands of Mahomedan unbelievers, in the days of its first magnificence must have been, indeed, refulgent with the precious metals and costliest marbles, apart from the universal use of gold and silver mosaics in its domes and vaults. We learn that the columns of the ciborium and the baldachino over the altar were formed of silver gilt, and the sculptured fruits and lilies which adorned it, and the cross which surmounted it, were of gold, and of gold were also the solea and ambones. And in the Church of the Resurrection in the same city, the underside of its wooden vault was covered with plates of gold by Basil the Macedonian. And in the church of St. Demetrius at Thessalonica, A.D. 584, there was a ciborium of silver and the shrine of the saint, which, from the description, seems to have been the prototype of many of those gorgeous shrines which enriched the churches of the Middle Ages. A description of this is given by Pseudo Joannes. He says:—

"The shrine—this work as holy as it is remarkable—stands in the midst of the temple, on the left side. It is hexagonal in form, upheld by six columns, with a like number of walls of fine silver, and ornamented with incised work; and its cover stands circular upon the six sides, and supports, as base, a silver sphere or dome, ornamented with lilies and stalks; and above shines the sign of life, the adored cross."

The three immense basilicas at Rome—San Giovanni in Laterano, San Pietro, and San Paolo fuori le Mura—were rich in the precious metals. St. Peter's possessed a silver ciborium,* and St. Paul's another; and the confessional or crypt of the latter was lined with silver plates, the gift of Valentinian, A.D. 438. If such was the custom at Rome and Constantinople, we may be sure that the example was followed in other churches, wherever it was safe to do so, and they were far from those barbarian hordes which infested the north of Europe.

In some of the Italian churches, and also in Spain and Germany, are preserved some of those magnificent altar-pieces, called *pala d'oro*, generally of silver gilt. In the church of St. Mark at Venice, there is a superb specimen, uncovered on great festivals. It is of Byzantine workmanship, and richly jewelled, some of the precious stones being very large, and, if real, of an immense value. It was made in 976, by order of the Doge Pietro Orseolo originally, but was much altered by successive Doges. San Salvatore, Venice, possesses a very fine one, and at Torcello there are the remains of another. San Ambrogio, Milan, possesses one of the richest in

* St. Peter's also possessed silver doors, given by Pope Honorius I., and weighing nearly 1,000 lbs.

Christendom, which is slightly earlier than the Venetian one. The front is of gold, and the sides and back silver. The workmanship is superb, and, fortunately, the artist's name has been preserved: "Wolvinus, Magister Faber." It was presented by Archbishop Angilbertus II., A.D. 835, and represents Our Lord in the centre, surrounded by the evangelists and the apostles; and on each side scenes from the life of our Lord; the sides, angels and saints; and the back, the life of Saint Ambrose. It is richly enamelled, and set with jewels.

At Citta di Castello is a silver altar-piece preserved in the sacristy of the cathedral. It is of 12th century workmanship, and was given by Pope Celestine II. It also represents scenes from the life of Our Lord and various saints; and at Monza, in the Duomo, is a *palliotto*, or altar frontal, of silver gilt, of the 10th century, and there are many others scattered about.

In Spain, at the Cathedral of Gerona, is a silver altar and retable, and a curious baldachino, covered with silver plates, about the date of 1346. In the north of Europe, one of the finest of these *pala d'oros* was formerly at the Cathedral of Bâle. It now forms one of the chief treasures of the Museum at the Hotel Cluny, Paris, and is valued at 40,000 francs. At the religious troubles of the 16th century, this superb object was concealed in the crypt with other treasures, and so remained until 1834. When Bâle was divided into two separate cantons, the city canton and the country one, and the property equally divided between the two, this fell to the share of the country canton, who so little regarded its historical value compared to its intrinsic value, that it was put up to public auction at Liestal, 1836, and fell first into private hands, and was eventually sold to the French Government in 1854. It was given to the Cathedral of Bâle by the Emperor Henry the Second, surnamed the Lame, in gratitude of being cured of a painful malady, about the commencement of the 11th century, and although betraying Greek influence, is probably of Lombardic and not Byzantine workmanship. It is remarkable for the life-like energy of the figures in high relief, and exquisite workmanship of the foliage, animals, and filigree enrichments. It is of solid gold, on a foundation of cedar.

At Aix-la-Chapelle, one would naturally expect to find in the cathedral there, part of which was erected by Charlemagne, some indication of the influence of this tradition of the employment of the precious metals; but, with the exception of the pulpit, which is covered with silver plates, gilt, and enriched with ivories, and enamels, and some gold plates which decorated the throne of Charlemagne, there is very little. I except, of course, the magnificent shrines and reliquaries, as they are more portable objects, and scarcely come under the head of architectural adornments.

De Caumont, in his "Abècédaire," gives a representation of a superb tomb which was formerly in the church of St. Stephen at Troyes; it commemorates Henri, Comte de Champagne, who died in 1180. It was thoroughly an architectural composition, and unlike a reliquary, although it was covered with silver plates and enamels on copper. The effigy of the count reposed under a sort of altar tomb, consisting of open arcades resting on columns; the arches were round, and in each spandrel was an angel holding a scroll; the whole surface was profusely enriched with plaques of enamel and inscriptions.

The tomb of St. Margaret, in the church of the same name, at Cortona, is a splendid work of the 13th century, with a silver front, and the silver decorations of the chapel of San Carlo Borromeo, in the crypt of Milan cathedral, are too well known to need anything but the briefest of notices here.*

I have now traced the history of use of the precious metals in architecture. In these days they are far too precious to be used except in ordinary currency, or in small objects of use or luxury; the day has probably for ever gone by when their use could be applied to any other purpose.

Bronze.

This mixed metal has been known and made use of from the earliest ages, ages so remote that, so far as this world's history is concerned, it would be impossible to fix a date as to when

* At Florence, in the Opera del Duomo, is preserved a superb silver retable, beautifully enamelled, 1366, but not finished until 1477. It is 5 feet high and 15 feet long, and is divided into twelve compartments, and in the centre is a fine figure of St. John. Several artists worked on this, including Ghiberti, Orcagna, Verrochio, and others. In the Church of the Annunziata, in the same city, the high altar, supposed to have been designed by Leonardo da Vinci, is of silver, enriched with alto-reliefs in repoussé work, and is surmounted by a silver tabernacle; another very sumptuous silver altar, surmounted by statues in the same precious metal, bearing the tabernacle, is in the Chapel of the Holy Sacrament in the Duomo at Pisa, the gift of Cosmo di Medici; it was twice taken by the French, and redeemed on payment of immense sums of money.

it first appeared, or which particular family or group of the primeval races first made use of it. Even Biblical chronology speaks of bronze or brass as appearing in the very earliest times, and Tubal Cain, in the seventh generation from Adam, is spoken of as the "instructor of every artificer in brass, or bronze and iron." The bronze age, we know, was in many places co-existent with the stone age, and we find instruments of bronze side by side with worked flints of the neolithic period; and there is this peculiarity with regard to the use of bronze, which is a mixed metal, composed, roughly speaking, of nine parts of copper and one part of tin, and that is, we do not find either of these two separate metals in their unmixed state alone, or by the side of bronze weapons or instruments. The alloy appears, but the parent metals are absent, almost pointing to the fact that these bronze implements must have been imported or procured from some race which were in advance of all others in civilisation. What this race was, or where it came from, or at what period of man's first appearance on the world, we know not; one thing we are certain of, and that is, that the early dawn of our historical period is but the yesterday of an antiquity so remote that it is incapable of being measured by any historical standard. We do not find these bronze celts, or lance or arrow heads, confined to one country; from the boundless steppes of Asiatic Russia, throughout the whole of Europe, the Northern shores of the sandy deserts of Africa, or the once densely populated plains of Asia, they are found differing but slightly in shape or make. We find a parallel case in the use of those beautiful polished jade celts, in the tumuli of races far removed from any place where jade or *lapis lazuli* exists, and if one was imported as a rarity, it is but reasonable to suppose that the case is the same with regard to the use of bronze. Having thus briefly introduced this subject of bronze, by showing the remote antiquity of its use, let us lift the curtain of history, and trace its appearance, not in weapons or tools, or small objects of use, but as a veritable architectural adornment.

I have already alluded to the sparing use of metal work in Egyptian temples, in consequence of the beauty of the materials of which they were built; and bronze, like the precious metals, does not seem to have been much used, except perhaps for doors, no remains of which are extant; but bronze was largely used for smaller figures of the gods and altars, and other portable objects.

Herodotus gives us a very circumstantial account of the appearance of Babylon, and speaks of the hundred gates of brass, or bronze, which he describes as being very massive, and whose hinges and frames were of the same metal. The River Euphrates, dividing the city into two equal parts, all the streets which led from the river were also defended by smaller gates. The Prophet Isaiah alludes to these. "Thus saith the Lord to Cyrus, I will go before thee, and I will break in pieces the gates of brass." The temple of Jupiter Belus, in the centre of the city, had huge gates of brass. Had these smaller gates, leading from the river been closed, it is probable that Cyrus would never have taken the city in the artful manner he did.

As to the form and fashion of these brazen gates, they were not of solid metal, but were of wood, strongly bound and clasped with bronze straps, richly ornamented with figures in relief. There are now in the vestibule to the Assyrian Gallery in the British Museum a pair of these gates, almost as fresh and as perfect as they were left by the workman 2,750 years ago—an irresistible argument in favour of the eternal nature of bronze. The history of the discovery of these is very curious. About eight years ago, a grave-digger was digging in one of those mounds marking the position of Ballawat, about nine miles to north-east of Nimroud, and he struck upon some fragments of bronze, and being fully alive to the desirability of turning an honest penny, made off with his prize to Mosul, knowing the value that the Giaours set upon anything bearing the marks of those infidel wretches whom Allah had so justly destroyed. A friend of Mr. Rassam's fortunately bought these fragments, and sent them to him in England; and, on being examined, they were found to be inscribed with the legend of the tribute of the Zurái and Zidunái, who were no other than the Tyrians and Sidonians; this important discovery drew attention immediately to the place where they were found, and Mr. Rassam traced the site eventually, and commenced a proper exploration. Unfortunately, it was the village cemetery, and the difficulties were considerable, but not insurmountable, and he finally succeeded in unearthing the remains of the temple of Imgur Bel, the Jupiter Belus of Herodotus, but called by the Assyrians Nergal, the giant god of war, a sort of compromise between Hercules and Mars. The inscribed foundation stones gave the dedication of the temple by Assur

Nazir Pal,* the son of Tiglath-Adar, the son of Rimmon Nerari, the great and mighty king, the king of multitudes. Interesting as this discovery was, it was far surpassed by one on the opposite side of the mound; here, the labourers came upon an extraordinary mass of metal, seemingly involved in one huge Gordian knot of inextricable complication, crushed out of all shape, and corroded with oxidisation, and almost crumbling with exposure to the air. At first sight it almost seemed impossible to say what it was, or what it commemorated; this discovery was followed almost immediately by another, and again by the remains of a third. They found their way to the British Museum, and, by the almost superhuman toil and unwearying energy of Mr. Ready, they now once more resume their ancient forms, and tell us the wondrous story of Shalmanesar, the son of Assur Nazir Pal, the builder of the temple, who carried his victories from the Euphrates to the shores of the great sea of the setting sun, and who received tribute from the Phœnicians who dwell in the midst of the sea, silver and gold, tin and copper plates, and the teeth of the dolphin, the offspring of the sea. Here, on these hinges or straps the whole tale is told, in imperishable bronze, the long processions of tributary nations bearing their gifts; the king with his attendants and warriors; "the tribute of the ships of the Tyrians and Sidonians;" a representation of Tyre itself; the siege and capture of Dibbarna; the submission of the inhabitants; siege of the Hittite city of Parga; and the various military engines and battering rams, all so carefully shown; the tents and camps, and the ordinary avocations of camp; the making and baking of the bread for the soldiers, "all so faithfully portrayed on these brazen portals wide, rich with the record of a monarch's pride," and then the dedicatory hymn, which reads like a triumphal pæan:—

"With the mighty powers which Assur my lord had given me,
With the mighty weapons which the great hero going before had furnished, I fought with them;
From Karkar to Kirzam their defeat I accomplished,
Their soldiers and warriors with my weapons I smote,
Like Rimmon a deluge over them I poured. . . .
Their spirits I crushed and broke; the river Orontes
With their bodies I choked."

We know the sequel to all this. How, under Sennacherib—

"The Assyrian came down like a wolf on the fold,
His cohorts were gleaming with purple and gold."

* Assur Nazir Pal, in his inscription, says he raised gates of bronze and sargon, inlaid with copper. (Records of the Past.)

The mysterious dread that fell upon that mighty host in the dead of night, as the destroying angel passed through their ranks, the hurried flight to Nineveh, and how Sennacherib fell in the very temple, slain by his sons; the utter ruin of that mighty empire, the long ages of silence, and decay, and utter oblivion, as its records sleep beneath those grass grown mounds, until, by the simple act of a wretched Arab gravedigger, the whole history starts again to life, and preaches that text of "Vanity of vanities, all is vanity." If I wished to point a moral at this point of my lecture, these brazen gates of Ballawat would give a striking example of how a nation's history might be writ in bronze.

Before I dismiss these gates, I will briefly describe their form and fashion. They are entirely of beaten bronze, the groups and figures being in repoussé work, arranged in parallel bands between borders, decorated with small rosettes like rivets at stated intervals; these bands not only passed completely round the cedar or pine planking, but also round the immense posts which worked in sockets and caps of beaten metal. Each hinge, so to speak, was composed of two bands of repoussé figure work, each about nine inches deep, and separated by a plain strip of metal, and the wooden material of the door must have been exposed between each hinge; each folding leaf of the door was about twenty-two feet high by seven feet wide, and there were seven bands on each door. How wonderfully stately they must have appeared when they guarded the approach to the temple, the bronze and the polished wood forming such a beautiful contrast.

The Homeric period, which I think to be contemporary with this palmy period of the Assyrian empire, might be more properly termed the Bronze Age of Architecture, so universal is the use of this metal. I have already alluded to the Odyssey and Ulysses standing before the palace of Alcinous, and gave the metrical version by Alexander Pope. The literal translation of

"Fixed in amaze before the royal gates"

is really, "thought over many things before he arrived at the brazen threshold"—χάλκεον; and again, the same material is mentioned in connection with the walls—χαλκεοι μεν γαρ τοιχοι—for the brazen "walls." The treasury or tomb of Atreus, at Mycenæ, a curious structure with a pointed domical chamber, was originally covered with plates of bronze, the holes

still remaining in the stonework, and many of the nails were discovered among the *debris*. The repeated spoliations which this singular building must have experienced, during the long ages which have elapsed since its erection, will, of course, explain the absence of any such metallic decoration now. The fact of its also being called a "treasury" must have led to minute siftings and searchings after the precious metals, and everything worth taking would have been removed.

Dr. Schliemann, in commenting on the singular appearance of the sculpture of the Gate of the Lions, considers that the faces of the lions never were carved, but were of gilt bronze, and projected from the face of the stonework; and as he is such a careful and painstaking observer of even the smallest minutiæ, it is most likely that he is correct in this statement. With regard to the bronze plates, I find, from Dr. Schliemann's work on Mycenæ, that some of them are actually in existence, and in the possession of General Gordon, and also some of the nails. The tomb or treasury of Minyas, at Orchomenus, was decorated in a similar manner.

Those lines of Homer (Odyssey vii. 84 and 87), "The brazen walls extended from the threshold of the gate to the innermost part of the building," convey no empty meaning in these days, in the face of these discoveries at Mycenæ. The old classic story of Danaë being imprisoned in a brazen tower by her father, Acrisius, alluded to by Horace (Carm. iii. 16), "Inclusam Danaën turris ahenea," points probably to a tradition of this sort; and Pausanias (ii. 23) says that, in Argos . . . . he saw a subterranean vault, over which was the bronze chamber in question; and from his description of the treasury built by Myron at Olympia (vi. 19), the entire decorations seem to have been of bronze, and the weight of the metal employed was recorded in an inscription.

The Temple of Jupiter, at Olympia, appears to have been exceedingly rich in votive offerings, as one would imagine, from its connection with the history of the various Grecian states. In modern times, this famous central shrine of heathen mythology has been most carefully and minutely excavated and examined, and many of its artistic treasures have been brought to light; notably, that masterpiece of ancient art, the Hermes of Praxiteles, remains of the bronze doors and bronze ornaments of the acroteria, and some of the sculpture of the pediments, showing that bronze was used in connection with marble, as in the Panathenaic frieze at the Parthenon. One almost perfect figure of Apollo shows traces of a gilded bronze wreath, probably of laurel, as the holes exist in the sculptured hair by which it was attached.

Sophocles alludes to similar bronze decorations in Antigone (944-947). Indeed, the allusions are so numerous as to this custom, that it must have been universal in the early days of Hellenic or Argive civilisation, and was probably a survival of Pelasgic traditions, for we find the same universal use of bronze in Italy, probably introduced by the expelled Pelasgii, and carried to such perfection of workmanship and finish by the Etruscans, who had supplanted the early Pelasgic settlers in Italy. Unfortunately, beyond the tombs of the Etruscans, we have little or no remains of their architecture, but a single glance at any of the exquisite specimens of worked bronze, principally found in these tombs in the shape of lamps, candelabra, bedsteads, or biers and tripods, are sufficient proofs of the use of bronze in architecture. Pliny, in quoting from Varro's description of the tomb of Porsenna, speaks of it as being surmounted by a bronze circle or cupola, and Tertullian says that Rome was inundated by the immense quantity of bronze statues, over 2,000 in number, taken from the Volsinii, an Etruscan nation; and, according to Plutarch, Camillus was accused of having sequestrated for his own use some brass gates adorned with reliefs, part of the spoils of the conquered Veii.

The transition from the conquered to the conquerors is natural, and ancient Rome soon adopted a form of decoration of which it had been until then entirely destitute. The history of art in Rome was, in reality, the history of the successive subjection of other nations with whom art was inborn and natural. I have alluded to the Etruscan influence, and later on it was the same with Greece. Artists in Rome were generally foreigners; the Romans appreciated art very much in the same way as we do—it was fashionable; and what they did not plunder and rob from other nations, especially Greece and Etruria, Carthage and Egypt, they bought and acquired like ordinary produce. The spirit which inspired a Phidias, a Praxiteles, a Callimachus, or Lysippus, to produce on Attic soil such a succession of masterpieces, was entirely absent on the banks of the Tiber. With them, like with us, art was a good investment, and ministered to

their pomp and vanity. One of their poets, in writing to his mistress, says:—

"Do you ask why I am late in coming to you? A portico, decked with gold, has been opened to Phœbus by the great Cæsar. The whole was magnificently arranged with rows of columns of Carthaginian marble (plunder), among which was the company of daughters of old Danaus (plunder). There I saw Phœbus, in marble, more beautiful than life, reciting verses, though to his mute lyre (plunder).* Around the altar stood four life-like oxen, carved by Myron's hand (plunder all of it);"

And in another elegy he contrasts all this pomp with those more simple times—

"When these temples, now golden, first sprung up in honour of earthenware gods, and shrines built in no costly manner were no disgrace."†

The allusions to the use of bronze gilt are numerous in so many of the old Latin authors, poets, and satirists, that it would be wearisome to quote; but if we turn to the mute evidence of some of these buildings themselves, we find ample confirmation that their descriptions were not overdrawn. The Temple of Vesta, which is circular, had a dome covered with gilt bronze, and the same has been recorded of the Pantheon. Internally, the Pantheon still retains its bronze doors, but the gilt bronze plates which decorate the square coffers of its domed roof have all disappeared. The Emperor Constans II. was the first to spoil it of some of its bronze decorations, and Urban VIII. (Barbarini) completely stripped it; 450,250 lbs. of metal were carried away; some of this went to make the bronze baldachino over the high altar of St. Peter, the lining of the confessio, or tomb of St. Peter, and the bronze cannons of the castle of San Angelo, thus destroying what even the barbarians had respected, an act of vandalism which gave rise to that well known saying:—

"Quod non fecerunt Barbari
Fecere Barbarini."

In the chapel of the Holy Sacrament in the Basilica of San Giovanni in Laterano are four bronze columns, which tradition says were brought from the Temple of Jupiter Capitolinus, and had been originally made from the bronze rostra or prows of the vessels captured at Actium. Close to the Forum are those three remaining superb Corinthian columns of a temple which used to be called Jupiter Stator, but have since been renamed. Fergusson, in his History of Architecture, vol. i., page 276, is inclined to think that, from the extreme severity of the frieze, compared to the other portions of the order, which are highly enriched, it must have been adorned with a gilt acanthus scroll in bronze, and there is some probability in this, as that most perfect and lovely little temple dedicated to Caius and Lucius, the adopted sons of Augustus, at Nismes, shows unmistakably that the dedicatory inscription was bronze gilt, and it has been deciphered from the rivets or nails which attached each letter to the stone frieze. I have already alluded to the Forum of Trajan The basilica attached to this had a wooden roof, with bronze covered beams and coffers, and was profusely decorated with bronze trophies, and the statue of the emperor, which surmounted the well-known column which stood in the front of the basilica was also bronze. The Portico of Apollo on the Palatine was roofed with it. Among the very beautiful remains of wall paintings discovered at Pompeii, there are some which are remarkable for the peculiar perspectives of architectural design, with columns and architraves of a peculiar attenuated form. Mr. Fergusson is inclined to believe that these paintings represent a peculiar style of architecture, "which could only have come into fashion from the continual use of bronze;" and says further, that Vitruvius reprobates it, and Cassiodorus mentions it. With regard to the first authority, I can find no passage which would warrant such an interpretation; and with regard to the latter, I have not found at present any mention at all. But if such was the case, it is odd that not a single trace of such a style should be found amongst so many thousands of antiquities in metal which are being continually discovered; and still more strange that, at Herculaneum and Pompeii, where these paintings abound, not a single atom remains to bear out such a theory, while bedsteads, currule, chairs, tripods, candelabra, and lamps abound. In the gardens of the Vatican is preserved a colossal cone or pine-apple in bronze, which evidently surmounted some building in ancient Rome; and one of the finest objects in bronze extant in Rome, although not strictly architectural, is the equestrian statue of Marcus Aurelius, the finest and oldest equestrian statue in the whole world. This stands now in front of the Capitol, in the centre of the square. In looking at some of the paintings by Alma Tadema, in which the society and surroundings of ancient Rome are depicted with such

* Propertius, book iii., elegy 23.
† Propertius, book v., elegy 1.

scholarlike knowledge and minuteness, one can almost feel the enervating influence of that soft Italian climate, and realise how grateful the shade of those stately porticos must have been, when one could watch the throngs, as on pleasure bent, they paced with sandalled feet, and clad in ample toga or loose flowing lawn, the polished surface of those costly mosaic pavements, flecked with alternate light and deep shade, cast by columns of the rarest marbles; and the eye, dazzled with the motley throng, would seek relief by looking upward to the massy beams and coffers of the panelled roofs, refulgent in the reflected half-light with gilded bronze, or would turn to the wondrous statues of ancient art, lifted high above the moving mass on their richly decorated pedestals, calmly majestic, masterpieces of Praxiteles, Polycletus, or Phidias, of the purest Parian marble, or the burnished bronzes of Myron, ethereal in their beauty, the spoils of captured provinces; then, turning to the outside, the eye would have seen distant domes of gilded bronze shimmering in the haze, and towering above all the gilded Capitol and colossal statues of the same material reflecting the sunshine. Wherever you turned in ancient Rome, you would see bronze, either left in that exquisite natural tone of green oxidisation or resplendently gilt.

Miscellaneous.

THE AUSTRO-GERMAN EXHIBITION OF 1885.

The committee engaged in the organisation of the above display recently addressed a petition to Prince Bismarck, asking for the support of the Imperial Government. In this document reference was made to the Austro-German Exhibition of Art and Industry, held at Munich in 1876, and to the opinion then generally formed, that the repetition of such displays in important cities would be of undoubted advantage. An interval of six to eight years was then spoken of as being the most suitable, but in this instance a longer delay has been inevitable, as Berlin was selected for the next Exhibition, and up to the present time, that city has not possessed a fire-proof building of a suitable character. This difficulty having been removed by the erection of the Hygienic Exhibition, the suggestion was made in the document referred to, that this building should be utilised for the purpose indicated.

According to the most recent information published upon the subject in the German press, the proposal has met with the approval of the Chancellor, and of the Imperial Court. It is stated in the *Cologne Gazette* that the municipality of Berlin will, in all probability, take over or hire the principal building of the present Exhibition. In this case there would be held, in 1885, the proposed exhibition of industrial art; in 1887, an international trade exhibition; and in 1888 an electro-technical display. It had been at one time proposed to include France in the Exhibition of 1885, but this idea has been abandoned.

General Notes.

AGRICULTURAL RETURNS.—From a summary of the agricultural returns of Great Britain for the present year, lately issued by the Agricultural Department of the Privy Council, it appears that the acreage under the five main crops are:—Wheat, 2,613,147; barley, 2,291,984; oats, 2,975,377; potatoes, 543,455; and hops, 68,027. As compared with the returns for 1882, there is a decrease to the extent of 390,813 acres in the case of wheat, but an enlarged acreage in the case of the other four crops; thus of barley the increase amounts to 36,715 acres; oats, 141,512 acres; potatoes, 2,391 acres; and hops, 2,408 acres.

TANNING TEXTILE FABRICS.—M. Piron, a Belgian, has invented a process for tanning textile fabrics which renders them waterproof, and at the same time, it is said, proof against decay, while their suppleness is not diminished, and their weight not appreciably increased. Arguing from the high state of preservation in which the bands which surround the heads of Egyptian mummies are found to this day, and which are impregnated with a kind of resin, M. Piron had recourse to the substance extracted from birch bark, and which is now used to perfume Russia leather. When the fine white bark of the birch tree is distilled, it yields a light oil, nearly a fourth part of which consists of the special phenol, or carbolic acid, which gives the well-known odour to Russia leather. It is now found that the residue, or green tar of the birch, which is obtained from *Kostroma*, yields neither acid nor alkaloid, and it forms, with alcohol, a solution of great fluidity, which, however, when once dried, is unacted upon by alcohol. It is this substance, which will unite with the most brilliant colours, that is used by M. Piron for treating textile fabrics. Not only does it fill the capillary vessels, but it also coats them with a varnish of great elasticity, which is unattackable by acids and sea water, while it also stands great changes of temperature. The aromatic odour of articles thus treated drives away insects; there is no space for microscopic vegetation, and neither air nor water can penetrate into the tissues. This process is applicable to all vegetable products, such as sailcloth, cordage, blinds, and awnings.

Journal of the Society of Arts.

No. 1,607. Vol. XXXII.

FRIDAY, SEPTEMBER 7, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

SWINEY PRIZE.

The Council have to give notice that the next award of the Swiney prize will be in January next. Dr. Swiney died in 1844, and in his will he left the sum of £5,000 Consols to the Society of Arts, for the purpose of presenting a prize, every fifth anniversary of the testator's death, to the author of the best published work on Jurisprudence. The prize is a cup value £100, and money to the same amount; the award is made jointly by the Society of Arts and the College of Physicians. The cup now given is made after a design specially prepared in 1849 for the first award, by D. Maclise, R.A. Any person desiring to submit a work in competition, or to recommend any work for the consideration of the judges, should do so by letter addressed to the Secretary of the Society.

The following is a list of recipients :—

1849. J. A. Paris, M.D., and J. Fonblanque, for their work, "Medical Jurisprudence."

1854. Leone Levi, for his work on "The Commercial Law of the World."

1859. Dr. Alfred Swayne Taylor, F.R.S., for his work on "Medical Jurisprudence."

1864. Henry Summer Maine (now K.C.B.), D.C.L., member of the Legislative Council of India, for his work on "Ancient Law."

1869. William Augustus Guy, M.D., for his "Principles of Forensic Medicine."

1874. The Right Hon. Sir Robert Joseph Phillimore, D.C.L., for his "Commentaries on International Law."

1879. Dr. Norman Chevers, for his "Manual of Medical Jurisprudence for India."

Proceedings of the Society

CANTOR LECTURES.

THE DECORATIVE TREATMENT OF METAL IN ARCHITECTURE.

By George H. Birch.

Lecture II.—Monday, April 9th, 1883.

Bronze.—(*Continued.*)

In my first lecture I carried the history of bronze decoration in architecture to its zenith under the Roman Cæsars; it is now my intention to trace its decline, until the use of it becomes again prominent in the Lombardic school, and reaches its apotheosis in Italy, under the Renaissance or Cinque Cento. One can easily imagine that during those early centuries, when that vast Roman Empire was toppling to its fall, and Italy saw army after army of the devastating Goths and Huns defiling from the mountain passes, and spreading like locusts over the fertile plains, carrying ruin and desolation, and, under Alaric, sacking and burning the Eternal City itself, it was not likely that the arts could flourish under such circumstances. And in addition to all these adverse circumstances, the emperors of the East, like Constans II., already referred to, did not scruple to strip Rome of its artistic treasures, among which were the statue of Trajan, and the outer covering of bronze tiles of the Pantheon. We must therefore transfer our attention to Byzantium, or, rather, Constantinople, and take up this one thread in the skein of the arts thus thrown into such inextricable confusion and tangle by anarchy and lawlessness, triumphant over the ruins of an empire founded in violence and sustained by plunder, and which was finally to succumb itself to the same adverse influences. We know that Christianity had a deal to do with the decline of the arts, more especially plastic art. It never had defended the use of the arts in religion, but it hampered them with restrictions and traditions, and this was very natural. It could not have been otherwise, for when once art had to express the symbols and events of the Christian faith, it at once was fettered to certain traditions, beyond which it was heresy to pass. We do hear of an independent art at Constantinople, for secular purposes, but it was only a faint reflex of what had been; the column which Justinian erected, A.D. 543,

and which was covered with plates of bronze, and surmounted by a colossal equestrian statue of the Emperor Theodosius the Great, now at Barletta; and the one which was at Ravenna, representing the Emperor Zeno. The bronze horses now placed over the central door of the vestibule of San Marco, Venice, are curious examples of the vitality of bronze as an architectural ornament. These famous horses have trotted from Africa to Europe, then to the far East, then back to Italy, from there to Paris, and finally back to Italy. The best and most authentic account of these is, that they were originally brought by Augustus from Alexandria, and after decorating a triumphal arch in his honour, they were successively removed to other triumphal arches, in honour first of Nero, then Domitian, Trajan, and Constantine, the latter removing them to his new capital, Constantinople. From there they were taken by the Doge Marino Zeno as spoils, and brought to Venice, in 1204; removed to Paris by the first Napoleon, and finally brought back to Venice in 1815. Had they been of any other material than bronze, they never could have survived such vicissitudes.

Among the monumental works in bronze which emanated from Constantinople, some of the most remarkable are the bronze doors which decorate several of the Italian churches. I allude more particularly to those which are enriched with inlays of silver. The beforementioned church of San Marco possesses one brought from Constantinople, and which originally adorned the church of Santa Sophia, and, like the bronze horses, was brought to Venice as spoils of war in 1204. Other doors worthy of mention are those at Amalfi, in the Duomo, San Salvadore di Bireto, Atrani, the Benedictine church at Monte Cassino, and the church at Monte Santangelo—the last four examples were all the gift of one family, the Pantaleoni of Amalfi. Those of San Salvadore, Atrani, were given by Pantaleone Viaretta in 1087, "pro mercede animæ suæ et merita S. Sebastiani, martyris." At Amalfi, in the cathedral of San Andrew, it is Pantaleone di Mauro who gives them, in honour of the Apostle, and for the repose of his own soul. At Monte Cassino, another member of the same family gives the bronze doors, and these are enriched with silver letters, containing an account of all the possessions of this magnificently endowed Benedictine abbey—the head house of the order; they date from 1066. At Monte Santangelo, the Pantaleoni again are the generous donors of the bronze doors there. In the Duomo at Salerno are fine bronze doors, once containing silver inlays, given by Landolpho Butromile and his wife, 1099. The design consists of crosses and figures of six of the Apostles. The similarity of the five examples all point to a common origin; the same stiff Byzantine treatment of the figures and heads, which are shown by incising lines into the bronze, and filling them with silver. These were evidently done to order at Constantinople, and are ascribed to a Greek workman, Staurachios—Romanised into Staurontius—who flourished about 1050—1072.

Mr. Drury Fortnum, F.S.A., in his exhaustive and admirable handbook on "Bronzes" (one of the South Kensington series), says that the remains of the bronze doors of the basilica of San Paolo fuori le mura, at Rome, unfortunately consumed in the disastrous fire which entirely destroyed that ancient church in 1824, were of a similar design and composition, and probably by the same artist. Small portions of these have been preserved, but I have, unfortunately, not seen them. He mentions further that the great doors of the old Basilica of St. Peter, to which I have already referred, were of a like character, but in these last I am inclined to believe that the precious metal, silver, must have been in greater abundance than simple inlays, if they afforded 7,000 lbs. of that metal for plunder. At Ravello, near Amalfi, in the cathedral, are very fine bronze doors, of rather a different character, but still very early as to date. They date from 1179, twenty-seven compartments in each division, divided by rich bands covered with graceful scrolls and arabesques, in which grotesque figures and dragons are introduced; and at Monreale there are similar bronze doors from the same hand; these, together with the bronze doors of the cathedral at Trani, representing the history of Abraham and Jacob, are attributed to Barisianus of that place. Another worker at this period in bronze is known by the name of Oderisius, of Benéventura, who made the bronze doors at Troja. All these examples belong to the 12th century. At his own native place he probably executed the bronze doors to the cathedral, which are adorned with Scriptural subjects, forty of them referring to the life of Our Lord, and figures in relief of saints and bishops. They are traditionally said to have been made at Constantinople, and although betraying a marked Greek character, as all this early bronze work

universally does, both in Italy and Germany, is probably Italian work. Canosa, the ancient Canusium of Horace, possesses a very extraordinary church, dedicated to San Sabino, looking externally more like a Turkish mosque. Adjoining this is the tomb of Bohemondus, Prince of Antioch, resembling a small mausoleum. It is of white marble, with bronze gates of an elaborate character, and covered with reliefs, and arabesques, and inscriptions. Bohemondus died in 1102. The workmanship is peculiar, and, like the neighbouring church, partakes of a Saracenic character.

The next series of these superb bronze gates, as to style and character, in which the work is freer, the relief much higher, and the tendency to Byzantine tradition much less marked, are those well known gates of San Zeno, Verona, the Duomo at Pisa, San Clemente, Pescara, San Ambrogio, Milan, and the south doors of the baptistry of St. John, at Florence.

The names of the various artists who produced some of these doors have been preserved. At Verona, the Brothers da Figarola; at Pisa, Bonnano; at Florence, Andrew Pisano, the friend and contemporary of Giotto.

The Verona example, which is the earliest dated, 1171, is in the west portal of the church, and is in two divisions, each about 16 feet high by 6 feet 3 inches wide, and are divided into twenty-four panels each, separated by bands of pierced and chased work of a semi-circular section, with raised heads at the intersections of the bands, with broader borders; some of the panels are pierced, and show the woodwork behind. A portion of the design seems to represent a "radix Jesse," figures of kings and prophets in relief on a background of foliage, which is richly chased with bold and vigorous scrolls, and birds, and leaves. The present arrangements of the panels appears rather mixed, subjects from the New Testament occurring among others taken from the Old Testament. There is a similarity in the treatment of some of these scrolls to 12th century ironwork in England.

The south doors of the Duomo at Pisa are so well known, from the electrotype facsimile now in the Architectural-court, South Kensington, that a detailed description would be superfluous; the date of them is about 1180. The twenty panels contain events from Scripture history, and are more remarkable for the vigour of the composition of the groups than for their beauty, and are wanting in that richness of design which characterises the Veronese examples, but are superb specimens of bronze work, being first cast, and then worked up by the chisel. They are the work of Bonnano. The divisions between the panels are much like a raised cable moulding, and the framework surrounding them is studded with small rosettes. The great western doors are of bronze, by John of Bologna, and his successors, 1602. The western doors at Monreale are attributed to Bonnano. In Rome, the doors of the baptistry of San Giovanni are about the same date, 1195, and are the work of Piero and Uberto di Piacenza. They are small, compared with the preceding examples, and the ornamentation is confined to a few figures in relief, the architectural outlines. San Ambrogio, Milan, has western doors of bronze, with two small panels introduced, to which tradition points as portions of those which St. Ambrose closed against the Emperor Theodosius, for his cruel massacre at Thessalonica. And while mentioning Milan, I would here call attention to the superb bronze candelabrum in the Duomo, one of the most marvellous works which have ever been executed in bronze; it was only presented to the cathedral in 1562, but the date of it is 1203. A cast of this extraordinary work of art is in South Kensington.

The 13th century, an epoch so wonderful in the history of Art, produced at Pisa several generations of artists in bronze, known as the Pisani; and at Perugia there is a superb fountain from the hand of Giovanni di Pisa; it is in three divisions, the upper one only being in bronze. It is remarkable for the beauty of its sculpture in marble, and the admirable contrast with the bronze finish at the summit.

Andrea Pisano da Pontedera, Giovanni's pupil, made the south doors to the baptistery at Florence. These doors quite mark an epoch in bronze casting, and prepare the way for the famous work of his successor, Lorenzo Ghiberti. Andrea's gates are very lovely, and, perhaps, more monumental than Ghiberti's. They represent the life of St. John the Baptist, and allegorical representations of the virtues. The attitudes and general pose of the figures are like what Giotto painted, and Andrea was a friend of the painter. The inscription on them is Andreas Ugolini Nini me fecit. A.D. 1330. The renaissance of art, according to classical traditions, was now beginning to make itself felt in Italy, and when Ghiberti commenced his first pair of gates, gained in open competition, we see how thoroughly that influence was at work, until it approached its zenith in the concluding pair of bronze doors to the

same building. The first gates from his hands were finished in 1424. The panels represent the life of Our Lord, dividing the four doctors and the four evangelists, which occupy the lower and upper panels respectively. The subjects, although almost emancipated from the stiff rendering of the earlier traditions, are still sufficiently subordinate as not to interfere with the general effect, and are, to my mind, more pleasing in their quiet repose than the more naturalistic rendering of those of his last productions, the famous gates of which Michael Angelo himself, the chief apostle of the intensely natural school, declared worthy to be the gates of Paradise. They are lovely in execution and design, and wonderful rendering of natural objects, and have to be studied closely, carefully, and for a long time, to realise them entirely. Life is short, and art is long; and of all the creations of art which the mind of man has conceived, and his right hand brought to perfection, Ghiberti's gates stand pre-eminent. These last gates were completed in 1452; they had occupied him for twenty-three years. He died in 1455.

South Kensington Museum possesses electrotype casts of these gates, so that they can be studied here, in the midst of the smoke, and dirt, and turmoil of our own city; but, alas, under different conditions, for here they have been unfortunately covered with garish gilding, and one misses the mellowed tones and marble surroundings of the originals.*

How very different is the feeling displayed in the central doors of St. Peter's, at Rome, the combined work of Filareta and Simeone Donatello, the brother of the more famous Donato or Donatello; they were erected by Pope Eugenius IV., Gabriele Condolimeri, 1431. In these we have Scriptural history mixed up with historical events in the life of the Pope, both cheek by jowl with Leda and the Swan, and Ganymede, and satyrs, and nymphs, and nudities. Those in the Church of San Pietro, in Vincoli, by Pollaicello, representing the imprisonment and liberation by an angel of the apostle, are very fine; the accessory arabesques and *relievi* are most delicately worked. The bronze door of the sacristy at St. Mark's, Venice, is better, from the hand of Sansovino. The two subjects of its leaves are beautifully executed, the entombment and resurrection of Our Lord; but there is an unpleasant appearance of theatrical energy thrown into the smaller figures and heads. Sansovino also executed the six bas-reliefs in bronze of the choir screen; most of Sansovino's other works in St. Mark's are detached figures.*

One of the richest churches in Italy, in objects of art, is that of the Santa Casa, or Holy House, at Loretto, and certainly a place where bronze decoration can be studied to the greatest advantage, as it possesses some of the masterpieces from the hands of Girolamo Lombardo, Tiburzio Verzelli, and others. The bronze doors here are very fine, somewhat similar to the Pisan examples, divided into square compartments, with subjects from the Old and New Testaments, arranged as types and anti-types, with smaller figures of prophets and sybils. The central door is the work of Girolamo and his sons, the one to the left is by Tiburzio, and the one to the right by Calcagni. These doors were completed in the Pontificate of Paul V., Camillo Borghese, at the commencement of the 17th century. The baptistery in the same church is a superb piece of workmanship, by Tiburzio Verzelli; and in some of the lateral chapels are numerous bas reliefs in bronze, by Calcagni and others. But even this church is surpassed by that of San Antonio, Padua. Here the combination of precious marbles and gilded bronze, particularly in the high altar, is superb. Donatello worked on this, and made the bas reliefs and the group of the Madonna and saints; Riccio, the paschal candlestick to the left of the high altar, and Velluti, the pupil of Donatello, the panels and evangelistic symbols under the cantoria or singing gallery. The chapel of St. Januarius, attached to the Cathedral at Naples, is wonderfully rich in bronze works. The time at my disposal will not allow me to more than allude to the many magnificent monuments in Italy, where bronze has been introduced in combination with marble and stone with wonderful effect, and I will only briefly allude to some of the public fountains,

Besides these superb bronze doors, groups in bronze are placed above each. Over the south door is the decapitation of St. John the Baptist, over the eastern doors the baptism of Our Lord in the river Jordan, and over the north door St. John preaching, by three different artists, Danti, Sansovino, and Rustici respectively.

* The Church of San Lorenzo, at Florence, is superbly enriched with works of art in bronze, more especially with regard to tombs of the Medici family; the festoons of foliage in bronze around the red marble sarcophagus of Giovanni di Medici and his wife, are some of the finest specimens of bronze casting extant, and some of the monumental effigies of the same family in the Medici chapel are scarcely to be surpassed. They were executed by Donatello John of Bologna, and Tacca, his pupil. In the Loggia di Lanzi, stands the Perseus of Benevenuto Cellini, the casting of which is so graphically described by the artist, in his life written by himself. With regard to Florence, I have only mentioned these few works of art done in imperishable bronze, but they are a few among many. Florence abounds in works of bronze, especially railings and tombs.

which often owe their chief merit to the manner in which bronze has been introduced; as the Fontana del Gigante, or of Neptune, Bologna, the combined work of Antonio Lupi and John of Bologna; the figure of Neptune which surmounts this fountain is grand, and equal to anything of classic antiquity; Perugia, before referred to; Pisa, Florence, and Rome; one especially in the Piazza Mattei; and, lastly, the well-known bronze well in the cortile of the Ducal Palace at Venice.

Another very fine instance of bronze decoration is the Loggia to the Campanile of St. Mark, designed by Sansovino; the four very beautiful statues between the coupled marble columns are by his hand—Pallas, Apollo, Mercury, and Peace.

The three bronze pedestals supporting the masts from which proudly floated the gold and silver gonfalons, representing Venice, Cyprus, and the Morea—they were designed by Alessandre Leopardi, and are very beautiful castings, representing sea deities, tritons, and winged lions, and were erected at the commencement of the 16th century.

I have dwelt rather long upon this subject of bronze decoration in Italy, even to the extent of becoming wearisome; my reason is that in no other country can bronze, in connection with architecture, be studied to such advantage. The Italians, during the Middle Ages and the Renaissance, seem to have had a preference for this material, and to have combined it with the lovely marbles with which Italy abounds, and in so many ways, and with such unvarying success. One could almost fancy that the arts and traditions of the ancient Etruscans had never completely died out, but had sprung up among them spontaneously, and burst into blossom, but only again to fade and droop, and almost to die. It would be difficult to explain why, among the other branches of the Latin family in Spain and France, bronze does not seem to have been so extensively used. In Spain there is very little, and that little late in character. Toledo is richer, perhaps, in bronze, as it possesses two pulpits, occupying the same position as those of Milan Cathedral, the junction of the north and south transepts with what would be the choir in other cathedrals elsewhere, but in Spain, the capilla mayor, or choir proper, contains only the high altar, the choir extending by a passage across the transepts into the first three or four bays of the nave. The capilla mayor is separated by superb bronze railings, called in Spain a *reja*. The delicacy of the work of the panels and pulpits, and the richness of their marble bases, tell out wonderfully against this superb background of bronze, 30 feet high, enhanced as it often is with the prismatic hues thrown by the southern sun through the richest of stained glass windows. The same superb bronze *reja* is to be seen at Seville. Here, at the entrance to the capilla mayor, it rises to the height of 60 ft., and was the work of a Dominican monk, who also executed the pulpits; and the superb Moorish tower, one of the architectural beauties of the world, takes its name, "Giralda," from the colossal bronze weathercock, which is a figure of Faith, with a shield in one hand and an olive branch in the other, and which turns by the wind. Burgos Cathedral possesses some of those bronze *rejero;* although not so lofty as those of Seville, they are beautifully wrought. The *tenebrario*, or bronze candlestick, Seville, twenty-five feet high, the work of Bartolomé Morel, 1562, is, in its way, almost as beautiful as a work of art as the Milan one. At Santiago, the *ambones* are of bronze (1563), with very delicate bas reliefs by Juan Batista Celma; and at Toledo, I omitted to mention that the *ambones* there had been made from the metal of the tomb of Alvara de Lana, which he had caused to be made in his lifetime, but falling into disgrace, and he not being available, his enemies wreaked a poor revenge on his empty tomb. The Puerta del Pardon, at Toledo, has a central door of embossed bronze.

France, also, is poor in bronze work, with the exception of a few isolated monumental effigies, notably those of the two founders and bishops of Amiens, now lying at the west end of that superb nave on entering—Everard de Fouilloy, 1220-3, and Geoffroy d'Eu, his successor, 1223-37. They are of similar design: a slab of bronze, slightly raised from the pavement, and resting on the backs of six lions; on the slab reposes the full length effigies of the bishops under a canopy, and by the side of each, four angels with tapers and thuribles. The execution is remarkably good, the drapery very fine, and the whole composition full of monumental repose.

In the museum of French sculpture at the Louvre, is a fine copper effigy of Blanche de Champagne, wife of John, the first Duke of Brittany. It was discovered in a garden close to the Haras at Hennebont, once forming part of the grounds of the abbey of Joy, of which no remains exist. She died in 1283. The frequent revolutions which have periodically

convulsed France for nearly a century, and the religious excesses of the Huguenots in the 16th century, will probably account for the paucity of bronze decorations in architecture. In a remote village of Brittany, St. Jean du Doigt, in the department of Finisterre, there exists in the churchyard one of the most beautiful bronze fountains to be found anywhere. It was the gift of the Queen-Duchess Anne. In this work of art, the renaissance feeling is very marked. It is in three divisions; the upper one surmounted by a figure of the Eternal, standing on a column, round which are grouped four angels, hand in hand. The artist is unknown, but it is supposed to be Italian. From its remote position in this out-of-the-way village, it luckily escaped being melted down into sous during the "Terror."

It was not until the reigns of Louis XII. and François I. that the Italian influence began to make itself felt, especially with regard to bronze. François I., when in Italy, must have seen and admired many of the contemporary works in bronze; and, with that appreciation of the arts which always distinguished him, invited several of the artists to France. Among them were Leonardo da Vinci, Benvenuto Cellini, Luca and Andrea della Robbia, Primaticio and Paolo Ponzio, all of whom executed works for François in bronze, goldsmiths' work, marble, fresco, and oil painting, and terra cotta work. The palaces at Fontainebleau and Madrid, near the Bois de Boulogne, were then in course of re-building and erection, and the presence of these Italian artists gave an impetus to native French art, which had been languishing, but which afterwards bore such excellent fruit in the works of Jean Goujon, Bernard Pallissy, Pierre Franqueville, Jean Cousin, Germain Pilon, and Jean de Boulogne.

Of the works in bronze executed for the king by Benvenuto Cellini, the best known is that semicircular bas relief in bronze, known as the Nymph of Fontainebleau. Benvenuto, in his life written by himself, alludes to this. He says:—"I have had occasion to make several works in bronze for the King François, of which I finished, and some have been left unfinished through various hindrances. Amongst these I have finished a figure in bronze, seven 'arms' in length, enclosed in a semi-circle. This statue represents the Nymph of Fontainebleau, a charming villa belonging to the King." This was in 1544; in 1547, François died, and Benvenuto returned to Italy. It is a question whether this ever went to Fontainebleau, as in 1607 it is described as then being at the Chateau D'Anet, the former residence of Diane de Poitiers, Duchesse de Valentinois. From there it was brought to Paris, on the destruction of the Chateau, and was first placed in the Salle des Cariatides, in the Louvre, over a door whose panels are now filled with some of the most charming bronze bas reliefs, by Andrea Riccio, taken from a tomb of the Della Torre family, or rather Torriani, at the Church of San Fermo Verona, where it still exists, minus these beautiful eight bas reliefs. They were stolen from Verona during the French occupation in 1797, and never returned. Ponzio's work was principally on the tombs at St. Denis of François and Henri II., the bronze statuettes of Prudence and Temperance are very beautifully modelled. It is now ascertained that he also worked on the tomb of Louis XII., and Anne of Brittany. One of Ponzio's finest works is in the Louvre. It is the alto relief of Andrè Blondel de Rocquencourt.

John of Boulogne made that very famous equestrian statue of Henri le Grand on the Pont Neuf, not the present one, which is a modern copy, the original having been smashed in the frantic frenzy of '93, and a few fragments only preserved at the Louvre. John did not live to finish it, he worked on it at Florence. His pupil, Pietro Tacca, completed it, and it was packed off to France in 1612, but the ship was wrecked on the coast of Sardinia, and it did not reach its destination until 1614. The pedestal on which it was placed was adorned by four very beautifully modelled slaves, by Pierre Franqueville, whom the French claim also as a compatriot, and to whom I shall have again to allude. These slaves were, fortunately, not included in the general smash of the "Tyrant" on horseback by the Paris mob, and they found their way to the Louvre. The next great work in bronze was the group of Louis XIII., Anne of Austria, and the Dauphin, afterwards Louis XIV., which stood on the Pont au Change, in the Citè. The statues are now in the Louvre. They were executed by Simon Guillaim, who was born at Cambrai, the birthplace of Franqueville. Goujon, Fremyn Roussel, Cousin, and Pilon, although superb sculptors in stone and marble, have left little in bronze beyond portrait busts.

In the museum of the Louvre are four bronze dogs, that once decorated the foot of a pedestal on which stood a statue of Diana, erected by Henry IV. at Fontainbleau. These

dogs afterwards decorated the gardens of St. Cloud, and were brought to the Louvre after the destruction of that beautiful palace in 1870. I ought to have mentioned that Barthèlemy Prieur made some fine gates in bronze for the Montmorency tomb, formerly in the Chapel of Orleans, in the Celestines at Paris, now in the Louvre. During the reigns of Louis XIV., Louis XV., and Louis XVI., there was not much done in France in bronze, beyond a few equestrian statues of no merit, and nothing architectural beyond the bronze decorations of the state apartments, Versailles. It was not until the time of the first Napoleon that this important adjunct was once more employed; the Column Vendôme, a travesty of Trajan's, in bronze, and some few doors. Of late years, French sculptors are beginning to turn their attention to this beautiful material, and with that inherent art-feeling so strong in our volatile neighbours, are producing very beautiful works of art, although the tendency is more towards small objects than to architectural decorations.

In the strict sequence of the history of bronze in Art, Germany ought to be placed next to Italy, as bronze decoration there actually preceded the employment of that metal in Italy—I allude of course to Christian art. There can be but very little doubt that the prevalence of these bronze doors, for instance, in the German churches, as at Hildesheim, Mainz (on the N. side of the cathedral, brought from the ruined Liebfrauenkirche), Aachen, Augsburg, and elsewhere, is due to the influence of Charlemagne and his successors, and their connection, as emperors, with the south of Europe. Their frequent residence in Italy, probably made them acquainted with the use of bronze as an architectural enrichment. Constantinople was, perhaps, really the fountain-head from which they derived their inspiration, although, both in their architecture and subsidiary arts, they contrived to invest them with a spirit entirely their own, and purely Teutonic. From the 8th century to the commencement of the 17th, Germany produced a number of works of art in bronze, and there seems to have been several centres whence this industry emanated—Hildesheim, Augsburg, Nuremburg, Lubeck, and Dinant in Flanders. At Aachen, better known as Aix-la-Chapelle, we find some very early bronze work in the lion-headed door-handles and in the bronze grills, and also some early work at Cologne. The Monk Theophilus, who wrote a treatise on the arts, extols Germany as being skilled in the working of gold, and in the casting of bronze. The Hildesheim gates, attributed to the famous Bishop Bernwardus, 1015, are very different in design to the Italian examples of the same date, such as I have described at Amalfi, Atrani, and Monte Cassino. The two leaves of the door are in eight compartments. On the left the subjects are taken from the Old Testament, and on the right from the life and passion of Our Lord. The curious column of bronze, 15 feet high (1022), in which the passion of our Lord is again introduced, treated like Trajan's column, in twenty-eight spiral reliefs, now standing in the Domhof, minus its capital and surmounting cross. It was formerly in the Church of St. Michael, and was the work of Bernwardus. The bronze font, later in style, was given to the cathedral by a priest named Wilbernus. The design is exceedingly curious, supported on four figures representing the rivers of Paradise, Pison, Gihon, Hiddekel and Euphrates, and is covered with bas reliefs, both curious and valuable for their theological bearing on the subject of baptism; the superb corona, candelabrum, or chandelier, representing the Heavenly Jerusalem descending, a very beautiful idea beautifully worked out. All these works of art in one building show to what extent bronze could be used in the decoration of one building. These objects alone would be the pride of any city, and Hildesheim, although its works in metal may have been temporarily eclipsed by the discovery of those ancient classical silver objects known as the "treasure" *par excellence*, has reason to be proud of her famous Bishop Bernwardus. This prelate was not the only ecclesiastic who delighted in the forge, and the anvil, and hammer; St. Eloi, in France, who made the throne of Dagobert, now in the Louvre, and St. Dunstan, in merry England, both have left reputations behind them of being skilled in metal work, and their names are never likely to die out in either country, so long as the popular legends of "Le bon Roi Dagobert" and "St. Dunstan, as the story goes," enshrine their memories in the vernacular.

In addition to the bronze doors at Hildesheim, others exist at Augsburg, Cologne, Mainz, Gnessen, and Novgorod. All of these are essentially German. The Augsburg gates are reproduced in electrotype at South Kensington; they date from 1070, and have been called the beautiful gates—I expect, more from their rarity than from the bas-reliefs, which, as specimens of art, are rather

comic, but not wanting in vigorous treatment. An early work in bronze is the famous lion at Brunswick; but this, I think, is purely Byzantine; a cast is in the South Kensington Museum. Lubeck, one of the principal cities of the Hanseatic League, was another centre where bronze was extensively employed in architecture. There is a superb bronze effigy of Bishop von Bockolt in the cathedral, in addition to the font, but the finest specimen of bronze work is the "sacramenthaus," or tabernacle, in the Marienkirche; this rises to the height of 40 feet, and is as beautiful a work of art in bronze as that more famous one in stone, by Adam Kraft, in the Laurenzkirche at Nuremberg. On the door of the town-hall at Lubeck is a bronze plate, representing the Emperor in the centre, surrounded by the Seven Electors. In various churches in Germany and the Netherlands, are to be found bronze fonts of a very quaint and original form—the one at Hildesheim I have already mentioned. St. Bartholomew's Church, Liege, has one supported on the backs of oxen; and at Halle there is one of the finest of these fonts surmounted by a canopy; it was cast at Tournay by an artist named Lefebvre, in 1467. Electrotypes of all these can be seen at the South Kensington Museum. At Kiel, there is a curious bronze font of a very original design; the bronze bas reliefs encircle it, divided into two ranges by a band of shields, and it is supported by four very grotesque lions, seated on their hind-quarters, and with their front paws projecting. One of the handsomest fonts of this sort is at Munden, in the church of St. Blaise, surrounded by figures of the apostles and saints, and supported on four couchant lions, on which are winged crocodiles, surmounted by four grotesque human figures bearing the bowl of the font—a vigorous and original treatment.

The later works in bronze, and some of the grandest in this material in Germany, are to be found principally at Nuremberg, the home of the Vischer family, who for three generations carried on this important industry, and supplied some of the finest bronze tombs and shrines extant. At Nuremberg—

> "Quaint old town of toil and traffic,
> Quaint old town of art and song"—

in the church of sainted Sebald, is that masterpiece of bronze casting, the shrine of St. Sebald, the work of Peter Vischer, a wondrous work of art. The statues of the Twelve Apostles, which are placed against the piers supporting the triple canopies, are wonderfully free from that stiff, conventional rendering, and multifold complicated drapery, so much affected by Teutonic art, and are almost equal to Italian art in beauty and freedom. Some monumental bronze effigies, both from Peter Vischer's hand and his father's—Herman Vischer, who made the bronze font at Wittenberg—are among some of the finest monumental effigies in the world: Archbishop Ernst, at Magdeburg, 1495; Bishop Johann, at Breslau, 1496; Bishop George, at Bamberg; the before mentioned shrine, 1508-1519; and some of the best bronze statues, life size, which surround that stately tomb of Maximilian the "Magnificent," at Innspruck. As time is short, I will only mention, in addition to these monumental works of Vischer, the two very fine tombs of Charles the Bold, Duke of Burgundy, and Mary of Burgundy, at Notre Dame, Bruges. This last-mentioned tomb is not only curious on account of its design, but as a work of art in bronze; it is nearly half a century earlier than that of Charles the Bold, which was not completed until 1558. Mary's tomb was the work of Pierre de Bickere, of Brussels, 1502. One of the most curious uses to which the Germans applied bronze, was in letting into gravestones the device or the coat of arms of the deceased. The cemetery of St. John, at Nuremberg, possessed over 3,000 of these, including that of Albrecht Durer.

England, notwithstanding its insulated position, was not behindhand, although it cannot show such a wonderful succession of bronze works of art as are to be found in Italy. The first application of bronze, in connection with architecture, is to be found at Salisbury Cathedral and Westminster Abbey. At Salisbury, some of the abaci of the columns are in bronze; and at Westminster Abbey the fillets or bands, which connect the Purbeck shafts to the central pier, are of bronze, a very curious and instructive example of the use of it. Waltham Abbey, in Essex, is, perhaps, the earliest instance of the use of copper or bronze. Harold's original church was said to have been adorned with plates of gilt metal; and in the deep incised spiral lines which decorate some of the pillars, there are traces of their being filled in with metal, the rivets remaining. But our chief glory with regard to bronze are the monumental effigies of our kings, principally at Westminster. Henry III., 1272, Eleanor of Castile, 1291, the work of William Torell; William of Valence, half-brother to Henry III.,

1295. This effigy was really of copper plated over wood, and enriched with enamels; French work from Limoges. Then in order comes the tomb of Edward III., a very fine work of art, and surrounded by small statuettes of his children. These were of English workmanship, the work of Nicholas Broker and Geoffrey Prest, coppersmiths, of London. Most of these royal effigies had been originally richly gilt, and diapered with patterns and devices. Edward, the Black Prince, at Canterbury; Richard II., and Anne of Bohemia his queen; Henry V. Although tradition says that the mutilated wooden effigy which still surmounts his tomb was formerly plated with silver, and had a silver head, it is more likely to have been covered with plates of copper gilt. Lastly, the superb tombs of Henry VII., and Elizabeth of York, 1509; and Henry's mother, Margaret Countess of Richmond and Derby; these three last were the work of Torregiano, an Italian; but the grille or screen, and the superb gates at the west end of the chapel generally known as Henry VII., at Westminster, are supposed to be the work of Englishmen, Humfray Walker, founder, and Nicholas Ewen, coppersmith and gilder. There are many later works in bronze, such as the Richmond and Buckingham tombs in the same chapel, the equestrian statue of Charles I., at Charing-cross, and the large group of bronze in the courtyard of Somerset-house, by Bacon, of George III. and Old Father Thames, perhaps, one of the best, although one of the latest before the art became so utterly devoid of any real merit, and sunk into heavy and lumpish representations of individuals of isolated interest, and quite unconnected with architecture.

I have not mentioned brasses in connection with my subject, although strictly they should be included, as they are so eminently architectural; but the shortness of the time at my disposal, and the importance of two of the metals which I have not yet touched upon, must be my excuse. They are of a slightly different nature to bronze, and are made of a metal, composed not only of copper and tin, but also of lead and zinc.

The great difference between brass and bronze is this admixture of zinc, and the effect produced is that brass, as a material, although very beautiful for internal fittings, lamps, candelabra, railings, and gates, &c., cannot bear exposure to the weather. So long as the lacquer or polished surface lasts, and it is protected from exposure, brass is not only a useful but a highly ornamental adjunct to architecture.

Iron.

It is strange that this metal, the use of which is as ancient as bronze, and which as a pure metal is the most widely diffused of all, because there is scarcely any substance in nature which does not contain iron in some sort of combination, besides being the basis of nearly all colouring matter, does not seem to be so universally used by the primitive races, the preference being given to bronze. Doubtless the principal reason is, the difficulty of extracting it from the ore, for it rarely exists in a purely metallic state; and the difficulties are such with regard to smelting, that to the early untutored races they were almost insurmountable, and yet it does go back to the most remote ages, and there is abundant evidence to prove this, although, from its fatal tendency to oxidise, and leave no trace behind, specimens cannot be produced. It is to this fact that Egyptian and Assyrian antiquities can offer nothing to reward our research; but the Bible, as in the case of bronze, adduces Tubal-cain as a worker in this metal, and the allusions there are numerous. Certainly the most striking is that allusion in Job, "Oh, that my words . . . were graven with an 'iron' pen, in lead, in the rock for ever," prefacing that most wonderful outburst of prophecy, "I know that my Redeemer liveth;" but all these allusions in the Bible point only to the use of it in weapons of offence and defence, and instruments of agricultural or technical appliance. Perhaps the passage in I. Chronicles xxii. 3—"And David prepared iron in abundance for the nails and for the doors of the gates, and for the joinings;" and in Deuteronomy iii., 2, Og, the king of Bashan has that very prosaic and intensely 19th century article of domestic furniture, "an iron bedstead." But wherever you find these allusions, the iron is invariably wrought; and in Isaiah xliv. 12, there is a concise description of the process:—"The smith with the tongs both worketh in the coals, and fashioneth it with hammers, and worketh it with the strength of his arms." The stern unyielding property of iron is used often in a figurative sense, to express the utter impenetrability of any object, whether they be walls or gates.

I have alluded in my first lecture to the great Harris papyrus, in which bolts of black metal were spoken of; and in the Sallier papyrus a door is spoken of, of true acacia wood, inlaid

with iron. At Nineveh a large quantity of iron was found in one chamber, which proved to be, on examination, scales of armour, and some of this was inlaid with copper, showing that considerable skill had been exercised in the production, when one considers the difficulty of inlaying one metal into another, and that the hardest of all.

They also employed another process of covering iron with bronze, and this was done when they wanted strength, showing that they recognised the peculiar qualities of iron in construction: there are several objects in the British Museum thus manipulated.

Homer alludes to it constantly, not only the actual use, but also as figurative of extreme hardness. "The cornice high, with blue metals crowned, in colours of the sky," is generally taken as either iron or steel, as that process of further hardening iron was well known to Homer. In the Odyssey, Pope's translation—

> "And as when armourers temper in the ford,
> The keen edged poleaxe or the shining sword,
> The red-hot metal hisses in the lake."

With the Greeks and Romans iron was little used in an architectural manner, the imperishable properties of bronze being more extensively appreciated; and this traditional use, as I have pointed out in the portion devoted to bronze, was almost universal from the 4th to the 12th century; and it is not until this last mentioned period that we find iron again taking its place as an architectural adornment. The gradual development of its use is co-existent with the finest period of mediæval architecture, to our own times, and one which has not yet even arrived at its fullest period or zenith.

One of the most beautiful uses to which iron was applied during the middle ages, was for screens or grilles, hinges, railings, and vanes; the use is universal in Italy, France, Spain, Germany and England. In this country we possess some of the finest specimens of wrought work to be found anywhere.

Some of the earliest work is to be seen at the cathedrals of Durham, Ripon, and St. Albans. In the first-mentioned cathedral, on the north door of the nave, is still to be seen the famous sanctuary knocker, a knocker which had to play an important part in those early days, when the privilege of sanctuary was so often invoked against the lawlessness and turbulence prevalent in the land. It resembles the head of a lion, from whose mouth depends the ring or knocker, and is a curious specimen of 12th century art, wonderfully animated and vigorous.

It would be hardly necessary here to say much about the importance given to the hinge during the 12th and 13th centuries; some of the woodwork of the doors were entirely covered with a succession of the most graceful scrolls, terminating in foliage, and springing from the band or horizontal strap of the hinge. At Windsor Castle, on a door leading from the cloisters into St. George's chapel, is a superb specimen of 13th century metal work. It had been originally made for a different shaped door of Henry III. work, but had been reworked when the chapel of St. George took its present form, about the reign of Edward IV. In this instance the hinge form is entirely suppressed, and the door is covered with a series of pointed ovals, the centres of which, and the spaces between, are filled in with a succession of scrolls with foliated ends and sprigs.

Some very similar work to this door exists at Chester Cathedral, on a press in the vestry. In both cases the ironwork is used as a means of strength, the hinge form being entirely suppressed, and of the same character is the ironwork on the vestment presses in York Minster. These three examples show the wonderful power of design and adaptability of the material in the hands of the blacksmiths of the 13th century. But by far the finest specimen of this date in England is the exquisite ironwork which protects the tomb of Eleanor of Castile, in Westminster Abbey. I have already alluded to the superb bronze effigy itself, the work of William Torell, and at the time the tomb was erected, it was the only one with the exception of that of her father-in-law, Henry III., the re-builder of the abbey, of that series of royal tombs of the Plantagenets who seem now, even in death, to keep watch and ward around the shrine of St. Edward the Confessor. This chapel and shrine must have been protected by iron grilles or screens in the intercolumniations now occupied by the tombs of Edward I., Henry V., Philippa of Hainault, Edward III., and Richard II., the screen and the high altar forming a protection to the west. Eleanor's tomb not being so lofty as that of Henry III., or the ornamental grilles which surrounded the chapel, this exquisite specimen of ironwork was probably added as an additional precaution to protect the gold and jewels of the shrine, for Westminster was not the safest place for valuables, in spite of its sanctity; Edward I.'s treasure, which had been placed for additional security in the

Abbey, had been robbed about this time. Eaton Bray, and Norwich Cathedral, Merton College, and Lichfield Cathedral, have typical examples of the excellence of the workmanship of the smiths of this period, and in France, on many of the doors of the cathedrals, superb specimens exist, slightly different in design and composition from our English ones. The cathedrals of Angers, Rouen, Paris, and Noyon, have some of the best. At Paris those of the Porte St. Anne, and Porte de la Vierge, are attributed to the Devil, on the principle that everything very extraordinary in the way of human effort must depend upon supernatural influences. The usual design of these French examples differs from ours, in that the scroll work does not cover so much of the door, but springs more from the extremity of the horizontal strap hinge. At Canterbury there is a very beautiful grille, the perfection of lightness and strength, between the ambulatory and the tomb of Archbishop Meopham, of small double scrolls set back to back, and united with a small riband of metal twisted round.

During the next two centuries, in England, the excellence of the design rather retrograded. In the iron screen to the Chantry of Henry V., in Westminster Abbey, and the railings round some of the tombs at Canterbury, and at the Abbey, the decadence is very marked. One noted instance of the architectural use of iron is to be found at St. George's, Windsor, in the tribune or royal pew to the north of the altar, this has been traditionally ascribed to Quentin Matsys. But although there was a decadence in England, this was not the case in Germany, especially in those free cities of the empire belonging to the Hanseatic League. In these towns the smith seems to have taken a special delight in his work, and to have revelled in all sorts of quaint eccentricities, to show his perfect command over the stubborn material glowing on the anvil before him; and during the 16th, 17th, and 18th centuries there was scarcely a town or city of any importance which did not abound in specimens of the art of the smith. Not that all the German work was necessarily good, or equal to the French or English work, more especially with regard to the hinges of church doors, which depended rather upon eccentricity of form than upon the beauty of easily flowing scrolls. But, in imitation of natural forms of leaves the German school is especially clever, and also in embossing some portions of the work, so as to relieve it from flatness of effect, which had hitherto been principally done by punching and welding one scroll on to the surface of another.

The German school was also especially happy in the manner in which the metal was worked into the architectural design. Their work never seems to be an afterthought, but to have been especially designed for the position it was to occupy, whether it was a railing to protect a fountain, like the Schoenbrunnen, at Nuremberg, or the metal grilles in the Cathedral at Louvain, or those of the chapels in the Domkirche, at Augsburg. Both these cities which I have mentioned, Nuremberg and Augsburg, abound in specimens of wrought ironwork. One's steps are continually arrested in each by the exceeding beauty of the ironwork. Sometimes it is a bracket projecting from the wall, at other times a grille over a fanlight or in a balcony, or the wrought iron handrail of an external turret staircase, or the metal canopy to a well; and then the manner in which some of it blossomed into the most lovely flowers, in which the petals and stamens were all most delicately worked, shows how thoroughly these old craftsmen entered into the spirit of their work, and in this triumph of mind over matter invested it with a poetic interest apart from the technical skill required in the mere production of any given object of ironwork, no matter how prosaic the destined use might be.

In some of the old Flemish towns, so full of the old brick houses turned gable-way to the streets, or at Hanover, or Lubeck, Dantzic, and other north German towns, one's attention is often arrested by the artistic form given to the ends of the metal ties which bind the front to the back walls. In England we never get beyond a figure something like the letter S; but in Germany there is an infinite variety, some of exceeding beauty. At Nuremberg the number of artistic door knockers, in one street alone, is surprising. I should state, though, that a great number of these are bronze. Some of the most superb specimens of ironwork in Augsburg were due to the fostering influence of one wealthy family, the Fugger family, eminent bankers of that time, and to whom the Emperor Maximilian was largely indebted.

There is one marked peculiarity observable in the German work, especially of the 16th and 17th centuries; the artists particularly affected a very intricate Runic knot pattern, in which the lines threaded through and through one another, imparting additional strength; and also the grotesques which terminated the scrolls

were sometimes cut out of sheet iron, and welded on. The succeeding century introduced that curious form of ornament sometimes called "Rococo," or "Pompadour;" and the metal work of this period, although showing great delicacy of execution, has a weak appearance, from the prevalence of inverted curves and scrolls overladen with this style of ornament.

The Spanish iron work, what there is of it, is particularly good. Some of the grille work is very delicate. At Pampluna, there are good specimens, and at Salamanca the large windows of the cimborium, or central lantern tower, are filled with very delicate grilles, covering the whole surface of the window; and in nearly all the cathedrals, with the exception of Toledo, Seville, Burgos, and Santiago, the *reja*, or choir screen, is of wrought iron, more or less elaborate. South Kensington Museum possesses one of the *rejeros*, not an electrotype copy, but the screen itself, and it is a very fair specimen of the extreme delicacy and beauty of the workmanship of the Spanish blacksmiths. Some of the foliage is superbly wrought, after the Flemish and German manner, being bossed out from the back, while the finials and flowers are almost reproductions from nature, resembling some of the French work in the south, as at Toulouse.

Iron was also sometimes used for pulpits in Spain. In the church of San Gil, Burgos, there is a good specimen. The long connection between Spain and the Netherlands possibly accounted for the superiority of some of their metal work, due to Flemish influence or workmanship, but that is principally in the later work; the earlieris essentially Spanish, and was probably the result of Moorish tradition and artificers, who had always been clever craftsmen in the various metals.

In Italy, the art of the blacksmith was in no way inferior or behindhand, notwithstanding the prominence given to plastic or pictorial art; the principal use to which it was applied was for grilles and balconies. Those who know Verona will readily remember the old churchyard of Santa Maria l'Antica, with its beautiful wrought grille surrounding and enclosing the monuments of the Scaligers, or della Scalas, quiet enough now on their marble monuments, but recalling those times of the Montagues and Capulets,

> "Who thrice disturbed the quiet of these streets,
> And made Verona's ancient citizens,
> Cast by their grave beseeming ornaments,
> To wield old partisans."

Italy also produced very beautiful torch-holders, knockers, lanterns, and cressets; and Milan was the centre of an extensive industry both of the armourer and blacksmith. The Italian work consists principally of small riband work, but in the north the work is freer. Nothing could be more beautiful than the screen work in the Duomo at Trent; and it is the same with regard to the endless variety of balconies. I can conceive nothing more beautiful than the effect imparted to wrought iron by its surroundings in some old Italian city. The narrow, almost deserted lane between high walls and houses in deep shade, save where, through an opening, the sunlight falls in almost dazzling brilliancy; the intense blue of the cloudless sky above; the quaint projections of the balconies, with their graceful and fanciful forms of wrought iron work, and the contrast of the pale golden leaves of the vine trained against them; and the stillness and quiet, only broken by the shrill chirp of the cicada: it only wants Romeo to appear from round yonder corner, and Juliet to step forth on that balcony, to make the scene perfect.

In France there is not much left of the Renaissance period of wrought iron work, but to what perfection they attained can be readily seen by inspecting those superb gates in the vestibule of the Galèrie d'Apollon at the Louvre; they were brought from a chateau at Maisons, near Paris, traditionally said to have been designed by Mansard, at the commencement of the 17th century. But wrought iron work was very extensively used in France for small circular fanlights, staircases and balconies. The handrails of many of the large buildings in France, especially those erected during the reigns of Louis XIII. and Louis XIV., deserve to be studied for the very clever way in which the pattern is made to follow the incline, and to terminate with a sort of spur at the bottom step; and great fancy is often displayed in the numerous small balconettes defending the lower part of the windows, the casements invariably opening inwards; the lock and handle plates are also very elaborately wrought.

About the time of Louis XIV., great alterations were made in many of the cathedrals, and the choirs and chapels were surrounded by wrought iron grilles, those of Amiens Cathedral and the Abbey Church of S. Ouen, Rouen, are among the best.

In England, from Henry VIII.'s. reign to Charles I., there is not much to show with regard to ironwork, being mostly confined to

small objects, such as locks, fastenings, railings, round tombs, and small grilles; and although showing sometimes considerable beauty of design, can scarcely be considered as architectural. During the Commonwealth, we have an instance of a curious screen or grille recalling earlier work in the chapel of St. Anne, Farley-Hungerford. It was erected by Lady Margaret Hungerford, 1650, and is in two divisions, containing very elegant panels of scroll work, three in each, and the cresting at the top, representing the Hungerford and Halliday crests, is cut out of thin sheet metal, and was originally painted and gilt. At South Kensington Museum is some ironwork which came from Frome Church, Somerset, and is a very graceful specimen of early 17th century work, marking the transition between the well-defined and graceful work of the latter half of the 17th and commencement of the 18th century.

Dartmouth Church, Devon, on the south door, has a very curious hinge, which appears, from its general form and workmanship, and from its being incomplete in the lower part, as if it had belonged to an earlier door, and had been removed and placed here in 1631, which date occurs in iron letters placed on each side of the central stem. Against this notion, which seems on the first look to be a very reasonable one, a close examination will prove that the letters forming the date are not more recent than the remainder of the ironwork; secondly, that the form of the ironwork is not a hinge, but a covering of metal utterly unlike any other known specimen of 14th or 15th century work, and possessing marked peculiarities of its own; and I cannot but think that the date 1631 is really that of this curious work, and is an instance of a survival in a remote district, as at Farley-Hungerford, of earlier traditions which local blacksmiths had not entirely forgotten.

Miscellaneous.

THE PATENT ACT.

The Government Patent Bill became law on the closing day of the Session, and it comes into operation on the 1st of January, 1884. It also includes the whole of the existing legislation relating to the registration of designs and trade marks, the former being much simplified. The following abstract refers exclusively to patents for inventions:—The body now known as the Commissioners of Patents is abolished, the Patent-office being transferred to the jurisdiction of the Board of Trade. The term for which a patent is granted remains as before, fourteen years. The fees on application for provisional protection are reduced from £5 to £1, and the fees for completing the patent for the first term (four years in place of three as at present) are reduced from £20 to £3, so that the patent will be granted for a term of four years for a sum of £4. There is no alteration in the amount of the subsequent payments for the keeping up of patents from the four to the fourteen years, but in place of paying the £50 at the end of the third year, and the £100 at the end of the seventh year in lump sums, these duties are now payable at the option of the patentee either in one sum of £50 at the end of the fourth year, and one sum of £100 at the end of the eighth year, or by annual payments of £10 before the end of the fourth, fifth, sixth, and seventh years; £15 before the end of the eighth and ninth years, and £20 before the end of the tenth, eleventh, twelfth, and thirteenth years. By a curious arrangement, if a patentee desires to continue his patent alive for eight years, minus one day, he can do so for £40, in addition to the original fee of £4, by paying the fees in four annual instalments, but if he pays the fee at once he will be charged £50, in addition to the original £4. Patents will be granted to the inventor jointly with others, but the inventor must in every case make a declaration that he is the true and first inventor. The Act is silent upon the question of granting patents as "communications from abroad." Applicants for patents may, if they think fit, transact all their business with the Patent-office by post. It was stated in the "memorandum" on the first draft of the Bill that the various post-offices throughout the country were to keep on sale the stamped papers required in applications for patents, but there is no provision to that effect in the Act. Each application for a patent is to be confined to one patent only, but it may contain more than one claim. The procedure on application is as follows:—The inventor must lodge at the Patent-office a declaration and a provisional specification. These documents, in place of being referred to the law officers for examination, are to be referred to an examiner, who will see that the provisional specification fairly describes the invention, and that the "title" sufficiently indicates the subject-matter of the invention. The examiner has also to report to the comptroller (the officer at the head of the Patent-office), whether the application conflicts with any other unsealed application in the office. The provisional specification having been approved, the applicant must then prepare his final specification, and lodge it at the Patent-office within nine months from the date of application. This specification is also referred to an examiner, who has to ascertain that the specification is properly

prepared, and is consistent with the provisional specification. The examiner, in the cases of both provisional and complete specifications, is to report to the comptroller. If the applicant is dissatisfied with the decision in either case, he can appeal to the law officer. If the complete specification be not accepted within twelve months from the date of application, the application is to become void. The provisional specification is kept secret until the complete specification is filed, but after that both provisional and complete specifications are printed and open to public inspection. A period of two months is here allowed to elapse to give an opportunity of entering oppositions, which may be done by "any person" on the ground of (*a*) fraud, (*b*) that the invention has formed the subject of a prior patent, or (*c*) that there is a conflicting application of prior date pending in the office. If no opposition has been entered, or if the opposition has been unsuccessful, the patent is then sealed. Specifications may be amended by way of disclaimer, correction, or explanation. The comptroller is to decide upon all applications of this nature, and upon any oppositions which may be entered against them, there being an appeal from his decision to the law officer. A provision is also introduced for the purpose of enabling the patentee to disclaim, by leave of the judge, during the progress of an action, proceedings being stayed so as to allow the patentee to apply at the Patent-office in the prescribed manner. The Board of Trade has power to grant compulsory licenses in default of the patentee granting licenses on reasonable terms, and on proof that (*a*) the patent is not being worked in the United Kingdom; (*b*) the reasonable requirements of the public are not supplied; (*c*) any person is prevented from working or using to the best advantage any invention of which he is possessed. The jurisdiction of the Privy Council in cases of prolongations of patents is retained, but their power of confirming patents is done away with. The repeal of a patent by an action of *scire facias* is abolished, but revocations of patents may be obtained on application to the Court, the grounds of such revocation being fraud, prior invention, or public user. The right of the Crown to the free use of patented inventions is abolished, but the Crown is to be at liberty to use patented inventions on terms to be settled by the Treasury. In all legal proceedings with respect to patents the Court may, and at the request of either party shall, call in the aid of an assessor. Letters patent may be granted to the personal representatives of deceased inventors. The clause of the Patent-law Amendment Act, 1852, by which the British patent lapsed with the expiry of any foreign patent of anterior date, is not re-enacted. The Act does not apply to the Channel Islands. The provisions as to the registration of documents at the Patent-office, the printing and publication of specifications, and the preparation of indexes and abridgments, are not substantially altered. The Patent-office Museum at South Kensington is transferred to the Science and Art Department. The comptroller is to issue an illustrated journal of patent inventions, as well as reports of patent cases, and is to keep this journal and complete specifications of all patents in force, on sale. Power is taken to join the International Union for the Reciprocal Protection of Patents, and when this is done the anterior publication of a foreign or colonial specification will not (for a limited time) affect the British application. The manner in which the Act will work will depend to a very large extent upon the nature of the rules and regulations which the Act empowers the Board of Trade and law officers to issue.

THE FISHERIES EXHIBITION.

No. II.

It is hardly necessary to say that the capture of sea fish by means of nets is the chief subject to which the Fisheries Exhibition draws attention. Of all modes of fishing, that known by the name of trawling, or beam-trawling, is the most important. It is calculated that, by this method, as much as nine-tenths of our fish supply, not including herrings and pilchards, is obtained. The centre, so to speak, of this trawling is the great Dogger Bank, in the North Sea or German Ocean. It is from this vast field that the London market, and most of the country ones too, are mainly supplied with soles, turbots, and brills, which are technically termed "prime" fish, and with the tens of thousands of tons of cod, plaice, haddocks, whiting, and other commoner kinds. This great fishing-ground lies between the coasts of the British Islands and those of Norway, Denmark, and Holland; and principally between the mouth of the Humber and the Skagerrack, on the north-west of Denmark. It is some 300 miles long, with an average width of about 70 miles; and the area may be roughly stated as 20,000 square miles. The various fishing-grounds of this great sandy shoal region are known to fishermen by the names of the North-West Flat, the Fisher's Gate, the Great Fisher's Bank, the Jutland Reef, the South-West Flat, the Silver Pits, the Well Bank, the Swarte or Black Bank, the Botney, the White Water, and by very many others of greater or less fame, which may be viewed as kinds of suburbs of the great trawling metropolis, the Dogger Bank.

It is to this great centre that British, Dutch, French, Danish, and Norwegian trawling-vessels resort with their crews of hardy fishermen, who, of all "toilers of the sea," have the hardest, roughest, and most dangerous work to do. The chief ports of departure for British trawlers are Hull, Great Grimsby, and Yarmouth. Some few hail from Ramsgate, and the port of London, which latter not many years ago included the famous fleet of Barking fishing smacks, numbering, when that now decayed town was at the height of its prosperity, some 250 sail of vessels.

They have of late years made the East Coast at Yarmouth and Gorleston their head-quarters, and the once well-known name of the Barking smack is now never seen but on the sign of some public house frequented by fisher-folk. Steam trawlers have of late years also largely come into use. The mode generally adopted by the British sailing trawlers is to sail in fleets under the command of one experienced fisherman, who is styled the "admiral." These vessels, which run from 60 to 100 tons or more, the largest generally hailing from Hull or Grimsby, carry crews of seven or eight men and boys, and remain on the fishing grounds for several weeks together, the fleets being visited by steam "carriers," as they are called, which take the fish from them and run them up to London direct, or land them at some port on the coast, to be taken thence by railway to the metropolis, or provincial centres of population. Thus a great loss of time is saved on the old plan of every vessel marketing her own fish. A very pretty sight is a fleet of trawlers on a fine warm day, or bright moonlight night, the wind filling their sails sufficiently to make the seven to twelve hours trawl go pleasantly, as the vessels travel three to four miles an hour with the tide. But the reverse picture is one of the most unpleasant that can be imagined; when the day or night is stormy, the weather cold, the nets and gear get fouled, and the fish have to be got to the carriers in a tempestuous sea. It then requires a very imaginative sailor to "pity folks ashore," whatever be their dangers; and at the present moment North Sea fishermen are threatening a strike against the "boxing" system, on account of the very great dangers often incurred by the smack's boats in taking the fish in boxes to the "carriers."

The trawls are let down when the "admiral" gives the signal, and after that, if the weather be fair, the majority of the crew get some rest. The "admiral," when he considers the right moment has come, according to circumstances, gives the signal—which at night is a rocket—to haul in the trawls. This is very hard work, and the operation, which engages all the available crew, takes from one to three hours, according to the state of the weather. The scene on deck when the net is emptied is a very lively one; all kinds of fish—good, bad, and indifferent—writhing, jumping, or crawling about, intermixed with oysters and crustaceans. At night, under the lamplights, it may be called "weird." Then follows the separation of the valuable, or "prime" fish, from the inferior kinds—called, in market phraseology, "offal" fish—and the throwing overboard such as are altogether worthless. The dogfish, before this last mentioned operation, receive a very emphatic tap on the head from the fishermen, who look on them as the most deadly enemies to the fishing interest.

Preparations for lowering the trawl again succeed, and when this is effected, there is the "gutting" and packing of the valuable fish in boxes or "trunks," to be done in readiness for the "carriers" to take them away. Shipping them on the carrriers is, as just intimated, often very dangerous work for the small boats, and many lives are lost in bad weather during the process. A steam carrier can take nearly 3,000 trunks of fish, of about two-and-a-half feet in length, and one-and-a-half feet in breadth. These are the packages which the "fellowship porters" may be seen, from London-bridge, carrying up every morning into Billingsgate-market, where the majority of them are sold on the men's heads, the buyers, in the hurry-skurry of the proceedings, and limited space, being obliged to "buy a pig in a poke," trusting to intuition and the "custom of the trade." This is the way in which Billingsgate is supplied, and the routine is carried out day after day all through the year. Trawlers which do not regularly supply the London market, such as those which sail from Brixham and Plymouth, are governed by more local conditions.

From certain points of view the trawl-net seems but a rude and simple contrivance, but its adaptability to its purpose cannot be denied. In a general way it may be spoken of as a large bag-net, something in the form of the letter V, tapering almost to a point. Its length for ordinary deep-sea fishing varies from 70 to 80 feet, and its breadth at the mouth from 40 to 55 feet—trawls for pleasure yachts, and for shrimping, being, of course, much smaller. The mouth of the net consists of a beam of wood attached to, and supported by two heavy frames of iron, called the trawl heads, in the shape of the letter D, the curved side of which points away from the mouth. They stand between three and four feet from the ground, and this forms the opening of the net, the upper part of which is lashed to the beam. But the under part of the net, attached at each end to the bottom of the iron "heads," forms a semi-circle, the centre of which, during the trawling process, is from half to two-thirds the way from the mouth of the net. All round the concavity of the semi-circle is the ground rope, sometimes weighted with metal, and sometimes consisting of a chain covered round with roping; and this, dragging along the ground, disturbs the flat fish, which rising up find the upper part of the net above them, and gradually get swept into the lower part. This lower part terminates in what is called the "cod," or "cod-end," the extremity of which is from four to six feet broad, and forms the end of the V. It is into this that the fish get, and their escape from it is prevented by fresh incomers, and weeds and rubbish pressing against those already in it, while those which make a dash backwards to escape, generally find themselves in the inverted "pockets" at each side of the net, which open about twelve feet from the end of the "cod," and form *cul de sacs*. On the outside of the lower part of the "cod," flaps of netting, called "chafers" or "rubbers," are fixed to protect this part of the net, which of course has to undergo more friction than other part, as with its load of caught fish and rubbish it is dragged along the bottom. The ordinary mesh of a trawling net is about three inches from knot to knot, but is gradually

reduced to about one and a-half inches towards the "cod." Ropes, called "bridles," or "spans," four- to sixteen fathoms in length, are fixed to rings or swivels, called "ears," on the bend of the iron "heads," and these are joined together (forming, as it were, another V) by the "warp," or tow-rope, at about one hundred fathoms long, which is fixed to a "dummy" in the centre of the vessel, and passes out through a square opening in the port gunwale. Thus the towing of the trawl is always done from the port side of the vessel, and when hauled in, one "head" of the trawl lies in the opening just mentioned, and the other end round the stern, to which it is raised by what is called the "dandy-winch," which hauls in the additional rope called the "dandy-bridle." A capstan, often worked by steam, hauls the "bridles," when the net is being lifted, and when the "cod" is got on board, the end is opened, and the fish fall out on the deck.

Many objections have of late years been urged against trawling, but it may be premised that no very great restrictions are likely to be imposed upon this method of fishing, which has been developed to such an enormous extent during the last twenty years or more, and has become one of the most important of our industries. The fact that it supplies us with the great bulk of our "prime" fish will militate against any restriction of it, and the public would never consent to any considerable diminution of its fish supply on the ground that future generations would profit by its partial abstinence. Of course, if it could be clearly shown that the present method of trawling really threatened a very proximate depletion of the sea of some one particularly valuable species of fish, the matter would assume a different aspect, and on philanthropic grounds the Legislature could easily be induced to intervene and, so to speak, protect posterity. But this danger of depletion has not been proved, and the evidence collected of recent years by inspectors of fisheries, commissions, and independent persons, who have the character, more or less, of being "experts," tends decidedly in a contrary direction. It has been most clearly demonstrated that the spawn of the great majority of fish is emitted at the surface of the water, and there vivifies; and hence the allegation so often made that the trawl-nets destroyed a very large quantity of fish spawn at the bottom of the sea has but very little foundation. Indeed, it is argued in favour of the action of the trawl-net on the bottom of the sea, that it does a positive good, by destroying large quantities of the eggs of some species of dog-fish which are viviparous, as it passes over the marine vegetation to which these eggs cling. That some harm may be done to this vegetation, which harbours the food of many fish, may be admitted; but even this has been denied, and the assertion made that as a slight disturbance of the surface of the ground on *terra firma* encourages the growth of various kinds of vegetation, in like manner that produced by the trawl-net below the water has a similar effect.

Another instance of unreasonable arguments which have been seriously alleged against trawling, is that it destroys large quantities of mussels, which are very valuable as bait for line-fishing; the fact being ignored that the great majority of mussels grow and flourish between high and low-water mark, where the trawl is very seldom used. The suggestion that the trawl, as it is slowly dragged over the ground, creates a disturbance that frightens fish away, may be taken for what it is worth. As a matter of fact, the trawl travels through the water very lightly, creating hardly any disturbance at all in proportion to its size. Anyone can testify himself of this who will handle the rope or trawl-warp, as he will find how easily and with how much elasticity the net follows the vessel's course. It would almost seem that some objectors to trawling had an idea that it is the beam of the trawl which is dragged along the ground; whereas, with the exception of the iron trawl-heads, which are only a few inches broad, the only thing which really disturbs the bottom is the ground rope, a heavy bit of old cable, which only sufficiently moves the sandy ground to make the flat fish lying on it, with a little sand over their backs, rise up to their capture. After all, however, the real answer to the complaint that the trawlers frighten fish away, is to be found in the fact that year after year, from the very same fishing grounds which have been harried for generations, our trawlers bring home an increasing quantity of fish. From time immemorial Brixham has been a trawling station, and the Brixham trawlers have always fished the same grounds in the Channel, which are of a comparatively limited extent. Year by year the Brixham smacks have been built bigger and bigger, and the trawl-nets have grown larger and larger; and yet, instead of any diminution in the supply of fish, larger fish than ever are now taken, and taken in greater numbers. The damage done by trawlers to the drift-nets and lines of other classes of fishermen is a question of a different kind; and it may be hoped that the International Convention at the Hague last year, and the passing of the Sea Fisheries Bill, and the appointment recently announced of another Commission to inquire into this matter, will result in a diminution of the evils complained of.

But notwithstanding the exaggerated, and in some instances groundless, objections to trawling, there is no denying the fact that the use of trawl-nets, as at present generally constructed, is destructive of enormous quantities of what are called "immature" fish, and especially of soles. Small soles, known in the trade as "slips" and "tongues," are not, indeed, immature in the strict sense of the word, any more than lamb or veal are immature, as, from a gastronomic point of view, small soles are of a sweeter and finer flavour than large ones; but they are "immature" in consideration of the fact that within a few weeks, or at most months, they would grow into fair-sized fish. Now setting aside these "slips," the number of still smaller soles and fry of other fish which are

annually destroyed through trawling, is almost beyond conception. It has been calculated that English smacks alone throw overboard something like 700 tons a week of small fish which have been crushed by the larger fish and rubbish ("dross") in the cod-ends of the trawl-nets; and of these, probably not one in fifty recovers itself. If we reckon these little fish at one-tenth of the size to which they would grow in a comparatively short time, we have, so to speak, a sacrifice of 7,000 tons of fish food per week. And this represents only a part of the destruction of immature fish which is going on daily all round our coasts. Now, however illimitable in a sense may be the supply of certain fish in the sea, that supply would necessarily be greater if only a part of the myriads of immature fish now destroyed in the "cod" ends of the trawling-nets were saved. With a view to effect this, several suggestions have been made as to the improved construction of the "cod" ends, and some of them are illustrated by exhibits at South Kensington. For instance, there is the patented trawl with a circular "cod" end, shown by Mr. George Read, of Byron-house, St. Patrick's-road, Deal. It is No. 34 in the catalogue, and is well worth careful inspection. The "cod" is formed of square meshes, which do not close like diamond meshes when a strain is put upon them, and it is kept distended by wooden hoops. Thus immature fish, and a large proportion of the rubbish gathered from the bottom of the sea, can pass through the openings. It can be fitted to any ordinary trawl-net; and Mr. Read has also a contrivance of ropes attached by which the "cod" end of the net can be hauled up on deck, by means of a derrick, without having to haul the beam up to the gunwale of the vessel, thus saving a great amount of labour and danger to the fishermen, especially in rough weather. Mr. C. G. von Schrieber, of Lowestoft, also exhibits an improved trawl with round or oval holes at intervals in the "cod" and for the escape of immature fish and rubbish. These escape holes are made of a material as soft and pliable as india-rubber, and are from twelve to eighteen inches apart from each other. The trawl-heads are ingeniously constructed so as to clear with safety submarine cables, and they can also be removed without interfering with the beam. Mr. J. W. de Caux, of Great Yarmouth, exhibits a trawl-net with wheels attached to the trawl-heads, and with the ground-rope fitted with rollers, so that the apparatus may pass smoothly, and with less friction, over the ground. A funnel is also fitted inside the net so as to prevent the escape of large fish, and the cod-end is so constructed that the meshes are kept open to facilitate the escape of small ones. Mr. de Caux has received prizes both at the Berlin and Norwich Fisheries Exhibitions for his invention. Another exhibitor of an improved trawl-net is Mr. E. W. Morris, of Lowestoft; the end of whose cod-net is distended by hoops, and composed of circular metal rings looped together for the escape of small fish. It would seem that the adoption, in some way or other, of this principle would go a long way towards solving the question of the escape of immature fish.

TURKISH SILK FARMING.

A late number of the *British Trade Journal* contains an article entitled, "A Glance at a Turkish Industry," from which the following particulars are extracted:—Mr. Griffitt has for many years been more or less engaged in the double task of combating the various diseases to which the silkworm is liable, and in trying to teach the peasantry how to regain something of the remunerative silk harvests which preceded the unfortunate year 1857. The loss suffered by Turkey when the various silkworm maladies first spread so violently is, he says, incalculable. He remembers the time when the wife of every gardener in the vicinity of Smyrna obtained from her crop of cocoons a sufficient return to enable her to pay for the clothing of her family for the whole year. In those days there were in the neighbourhood of Smyrna three large steam silk-reeling factories, where hundreds of women were employed, but when disease became general this industry had to be abandoned from lack of cocoons. *Flacherie* and *Pebrine* swept away the valuable indigenous races; large areas of mulberry trees were uprooted as being no longer required, and silk-farming came to be almost entirely relinquished. It is true that attempts were made to stem the tide of misfortune by the introduction of foreign eggs, but the peasantry, accustomed to handle their own large and beautiful cocoons, numbering 250 to the pound weight, became disheartened when they had to deal with the far inferior Japanese product of only half the size and weight. About this juncture Mr. Griffitt obtained possession of a quantity of native grain, representing a peculiarly fine race of silkworms, but which were very much diseased. Being aware, from experience, that no batch of eggs is ever entirely contaminated by disease, and being a firm believer in the system of regeneration by isolation introduced some time before by the French physicist, M. Pasteur, Mr. Griffitt carried it into practice, hatching his worms in separate cells, and jealously following with the microscope every subsequent stage of their development. With an expenditure of infinite patience and trouble, he at length succeeded in rearing his present entirely healthy and vigorous brood, the eggs from which yield about 150 lbs. of cocoons for every ounce hatched; 12 lbs. of the cocoons, as taken fresh from the brushes, yielding 1 lb. of silk of the finest quality. Having thus accomplished his first and principal self-imposed task, Mr. Griffitt set himself with equal ardour and determination to grapple with the second. It was not enough to be able to show the peasantry of Bournabat, near Smyrna, where his chief magnaneries are situated, of Nymphio, and of the island of Mitylene, that he had mastered the dreaded

Pebrine and *Flacherie;* but, determined to leave no opening for misunderstanding or carelessness, he went among the people personally, with supplies of healthy eggs. In this manner he taught the farmers and peasantry the precautions they should observe, and secured their self-interested co-operation by making them partners in the season's venture. Even then he was occasionally baffled to some extent by the appearance of diseased moths bred from absolutely healthy *graine*, the result of infection caught from diseased worms still in the neighbourhood. Frustrated for the moment only, he still persevered, and now, after years of unremitting struggles with the enemy, he has restored to that district of Turkey some of the prosperity in silk-raising which it enjoyed thirty years ago. During the past season Mr. Griffitt has scarcely lost a single worm through disease, and his peasant friends have been almost equally fortunate, although others in the same localities, using French eggs, but without the advantage of a paternal director, have again lost heavily through the ravages of *Pebrine*. Accordingly, the most convincing proof that could be offered of the happy effect of Mr. Griffitt's labours among the Turkish peasantry in the places alluded to appears in the following specimen cases of this year—a few instances out of many where educations of silkworms on the Pasteur cellular system have been attained without loss from eggs previously passed under the microscope:—Elleni raised 247½ lbs. of cocoons, which sold for 1s. 2d. per lb., £14 8s. 9d.; she expended for mulberry leaves and a girl's help, £2 7s.; leaving a net profit of £12 1s. 9d. This peasant woman attended to the worms without aid during the first three ages, and was assisted by a girl throughout the last two. Adriana's crop consisted of 151¼ lbs. of cocoons, from which she reeled 15 lbs. of raw silk, selling the same at 15s. per lb., £11 5s.; the cost of reeling, &c., was £1 2s., leaving a net profit of £10 3s. Possessing her own mulberry bushes, and having two young daughters, who assisted her during the last age, her outlay was small. Dhepinon and Costoula had a crop of 418 lbs. of cocoons, which produced 44 lbs. of raw silk, and sold at 15s. per lb., £33; the cost of reeling, &c., was £3 5s.; leaving a net profit of £29 15s. These two sisters were also the owners of a small mulberry garden, and were assisted during the last age by two daughters and a son. "Here," as Mr. Griffitt points out, "are poor Turkish peasant women who have acquired, by a few days' labour, what would have taken their husbands three months to earn."

COAL AND IRON INDUSTRIES OF RUSSIA.

H.M. Secretary of Legation at St. Petersburg says that until the year 1850 the working of coal was almost entirely confined to the basin of the Don, and the output was only about 3,000,000 poods—the pood being equivalent to thirty-six English pounds—of anthracite yearly, the result of private enterprise. The coal-fields in the Ural, the Caucasus, and in the Island of Saghalien produced at the same time but 5,000,000 poods annually. As regards the situation of the various coal deposits, that in the Government of Moscow is considered the most useful, taking into consideration the gradual destruction of the forests in Central Russia; that of the Don basin, by the ease with which it can be brought into connection, by means of railways, with the North of Russia, and especially with the Volga and Black Sea, furnishes the railways and steamers plying on the above mentioned river with a considerable supply of fuel. The coal deposits in the Ural Mountains are situated in the centre of a country rich in minerals of every sort, and their close proximity to the River Kama will admit of their being the source from which fuel will be drawn for the use of steamers on that river, and on the Volga. In the centre of the beetroot sugar producing country, about Kieff and Elizabethgrad, is another vein of coal; and there is also one in the centre of the great mineral deposits of those mountains. With the increase and improvement in railway communication, the output of coal has shown a marked increase. For 1868, the output for Russia—Poland excepted—was 12,000,000 poods; in 1870, 22,000,000 poods; in 1872, 48,000,000 poods; in 1874, 54,000,000 poods; in 1876, 83,000,000 poods in 1879, 112,000,000 poods; and in 1880, 122,000,000 poods. The chief obstacle to the more general use of coal throughout the empire is the excessive dearness of transport by rail, which frequently even surpasses the actual price of the coal. Of 2,700,000 poods of coal worked in the southern portion of the basin of the Don, the production suddenly ran up to 9,500,000 poods in 1872; but in 1874 it was reduced to 3,000,000 poods a year. Since the construction of the Koursk-Kharkoff-Azof Railway it has increased to such a degree that in 1879 it reached 47,000,000 poods. As regards anthracite on the eastern part of the basin, from 4,500,000 poods in 1863, it has increased to 10,500,000 poods in 1877, and in 1879 the total production of this basin was 76,500,000 poods, of which 29,500,000 was anthracite. In the Ural basin, the output of coal was from 1,500,000 poods in 1878 to 4,000,000 poods in 1879. The principal places worked at present are Lounieff and Korchoun-Lazareff. There are also in Asia vast deposits of coal, at Kouznetsk, in the Province of Tomsk. On the Kirgiz Steppe, in the Provinces of Semiplatinsk and Akmolinsk, about 1,000,000 poods are annually worked, chiefly at Karagandinsk. In Turkestan, coal is worked in the Kara-Tau mountains. In the Province of Kuldja there are coal-mines worked by the Chinese with an output of 500,000 poods yearly. In Eastern Siberia, in the Island of Saghalien, a little coal is worked for the use of the fleet. In the Province of Primorskaia, on the Gulf of Possiet, and on the Amoor, near the mouth of the Souyfoun, the small amount of coal

worked is for the use of the Siberian fleet. Coal was imported in 1880 to the extent of 83,500,000 poods from Great Britain, 21,500,000 poods from Germany, and 8,000,000 poods from Austria, besides smaller quantities from other countries. The iron industry is especially developed in the Ural mountains, chiefly in the Provinces of Perm, Orenburg, Oufa, Viatka, and Kazan. In the Ural, the principal mines are those of Blagodat, Wyssokaïa, and Magnituaïa. The mines of Blagodat contain from 52 to 58 per cent. of iron, and about 57 per cent. of cast iron is obtained; that of Wyssokaïa from 60 to 69 per cent. of iron, and about 64 to 66 per cent. of cast iron. The mines of Magnituaïa are the richest, containing 66 per cent., and above, of pure iron; but they are situated in a country devoid of fuel. According to official returns, in 1879, it was estimated that there were 1,926 beds of iron ore, 772 of which were worked, and produced 37,000,000 poods of mineral. Wyssokaïa-Gora had the greatest output, namely, 5,000,000 poods; and then Gora Blagodat, with about 2,500,000; then follow the works of Kyshtym, Alapaieff, Kolounitsk, Slatavust, and Sytersk, which furnish about 2,000,000 poods each. Throughout the whole of Russia, in 1880, 27,000,000 poods of cast iron were manufactured, of which 16,000,000 poods were made in the Ural. Of the total quantity of cast iron made in Russia in 1880, 25,500,000 poods were made by using wood as fuel, and 1,500,000 poods with coal. The Province of Perm heads the list as to the quantity of cast iron made, with 1,400,000 poods, then comes the Province of Oufa with 2,000,000 poods, then Radoum in Poland with 1,500,000 poods. In 1880, 19,000,000 poods of steel were made, of which 2,000,000 in the Ural. It is a fact that the places where most steel is made are not those which produce the most iron. Thus the St. Petersburg Government in 1879 produced 7,000,000 poods of steel, and that of Orel in Central Russia 3,500,000 poods, then follow the two Polish Provinces of Warsaw and Piotrkoff, where 4,500,000 poods were made. The Province of Perm comes in the fifth, with hardly 1,500,000 poods.

THE WINES OF SICILY.

The average annual production of wine in Sicily amounts to between 110 and 130 millions of gallons, and, according to the French Consul at Palermo, there appears to be every probability of this quantity being considerably exceeded, as a large number of farmers are now planting vines on their lands, instead of, as formerly, neglecting them for the cultivation of sumac and the olive. In some districts, where the cultivation of the vine is carried on to a large extent, it is not an uncommon thing to find the vines producing as much as 2,000 gallons of wine per acre, and there are certain places where the vine produces the second year of its growth. The wine itself is not of the very finest quality, and the method of preparing it is not yet thoroughly understood in Sicily. Among the better class of Sicilian wines may be mentioned *Marsala*, *Zucco*, *Corvo*, *Muscat* of Syracuse, *Albaneto*, *Marcarella*, and the *Aromena*. Marsala is prepared exclusively in the Province of Trapani, and the centre of the wine industry is at Marsala, from which place it derives its name. The grapes from which the wine is made are not taken from one particular vineyard, but a selection is made of the finest varieties gathered from the best vineyards in Sicily. Zucco is produced in the Province of Palermo, on the estate of the Duc d'Aumale; there are two descriptions of Zucco, white and red, the former being made from the grapes called *cataralto*, and the latter from the *pericone*. The white Zucco is very similar in taste to Marsala, but has a finer and more delicate flavour, and is a much drier wine; the red is considered to possess very health-giving properties, and very little of it is exported, it being mainly prepared for home consumption. Although a wine of comparatively recent growth, the Corvo has already attracted considerable attention, and is highly thought of in Sicily. It is produced from the vines of Casteldaccia, the property of the Duc de Salaparuta. This wine is also of two kinds, white and red—the former a dry wine somewhat resembling Sauterne, and the latter a very similar wine to the Roussillon. Albanate, which is made exclusively in the province of Syracuse, has a beautiful aroma, but it is highly fortified with alcohol, containing over 17 degrees. Moscato, known as the Muscat of Syracuse, is a very sweet wine, containing a large proportion of glucose—in fact, it almost resembles a syrup. Malvoisie is produced in the vineyards of the Lipari Islands, and is considered an excellent wine, with an average alcoholic strength of 15 degrees. There are many other wines of a commoner description produced in large quantities in Sicily, intended, for the most part, for rexportation to France, but an excessive amount of alcohol is invariably found both in the white and red wines of this class. The total amount of wine produced in Sicily in the year 1880 was 114,400,000 gallons.

Correspondence.

MORE MATERIAL FOR PAPER-MAKING.

The note (*Journal*, August 17th) on the "Dwarf Palm" of Algeria, as a readily available and productive material for paper-making will, no doubt, attract due attention. On two subsidiary points further information is required; namely, the botanical name or order of the so-called "Dwarf Palm," and

the scope that Algeria affords for its collection and reproduction.

Meantime it may be well for me to mention another plant of the wilderness, recently brought to my notice, which appears to be more promising and productive—though its location is more distant. I refer to the *Yucca Draconis*, popularly spoken of as the "Giant Cactus of the Mohave Desert," and which is said to be spread over immense districts in south-western California, affording, it is asserted, an inexhaustible supply. Its capabilities as pulp for paper-making have already been tested on sufficiently large scale, and duly attested by certificates of experts given in connection with industrial exhibitions in the States, more especially one held by the Mechanics' Institute of San Francisco.

The following description of the Desert Palm is from an American paper:—"All the tree except the bark and leaves are available for paper-making. The fibre bleaches easily, and what is very desirable in a paper-making substance, it felts well and cooks well, as the phrases are. From the fact that this desert where it is so prolific is mainly alkaline, the fibre contains no resinous substance, and therefore turns out a clear quality of paper. Mr. Walker has erected a mill in the Soledad Canon, six miles from the entrance to the desert."

My own immediate object is to attract the attention of experienced men interested in the Indian Section of the Society's operations, with a view to raising the question whether it may not be highly desirable to have the *Yucca Draconis* introduced into India. I have high authority for the assurance that this "cactus"—which the same authority says is really a "lily"—"would grow every where in India." And, as appears likely, considering the aridity of the Mojave Desert of California, that this bounteous fibre producer would thrive in the sandy wastes of Rajputana, and other generally hopeless regions of the Peninsula, all interested either in the prosperity of India, or the increase of its exportable products, will welcome the chance offered for the introduction there of the Californian plant.

There is a further incidental excuse for my thus bringing the matter to the notice of Anglo-Indians. Just before the Session closed, Mr. Alderman Fowler—who is always ready to do India a good turn—put a question as to the probable advantage of propagating the esparto grass in that country. Mr. J. K. Cross replied, in general terms, that the attention of the agricultural bureau should be drawn to the subject. But the proposal at once suggests comparison as to the far greater fibre-yielding qualities of the *Yucca Draconis;* for whereas, I believe, the yield from esparto is only thirty per cent. of fibre, the *Yucca* is said to yield sixty per cent., a larger proportion of marketable result than is shown by any other product favoured by paper makers. Then, again, the esparto requires so much and such tedious manipulation in its preparation for the market, that the value to any producing country of the Californian plant must be immensely greater. It is true that the tedious peeling and sorting of the esparto might afford suitable means of utilising the illimitable resource of domestic industry that India possesses. Hence it may be well worth while for the esparto to be cultivated in or near some of the more thickly peopled provinces of India; while the *Yucca Draconis* should be encouraged in the "deserts idle" that, mainly because of ruthless denudation, are so prevalent in vast tracts of Upper India. And, if the *Yucca* can be cultivated within reach of rivers or canals, which would afford cheap means of transporting it to the deltas or coasts, where it could be "pulped" and prepared forexport as "half paper stuff," it seems to me that a very important new industry might, at comparatively small outlay of capital, be speedily established in India.

W. Martin Wood.

West Kensington, Aug. 28th.

Obituary.

Cromwell Varley, F.R.S.—Mr. Varley, the eminent electrician, who died on Sunday, the 2nd instant, at his house at Bexley-heath, had been for many years a member of the Society of Arts. He was a frequent attendant at the meetings of the Society, and one of the latest occasions in which he joined in the discussion was in April, 1881, when Mr. Preece's paper on "Recent Advances in Electric Lighting" was read. Cromwell Fleetwood Varley—whose two Christian names indicate his descent from Cromwell, through the Protector's son-in-law, General Fleetwood—was the son of Cornelius Varley, the great water-colour artist. He was born at Kentish-town on April 6, 1828, and in his youth was famous for his skill in swimming. He devoted himself to the engineering branch of telegraphy, and became chief engineer and electrician to the Electric and International Telegraph Company, an office which he held until the taking over of the telegraphs by the Government. He was associated with Robert Stephenson, Sir William Fairbairn, and others in devising the successful Atlantic cable; and his inventions and improvements in telegraphy and other departments of electricity were very numerous. One of the earliest of these was an apparatus for transmitting electrical signals, which so much increased the sensitiveness and trustworthiness of the relay, that it became practicable for the first time to work from London to Edinburgh direct—a proceeding impossible in the conditions of insulation previously existing. Mr. Varley was elected a member of the Society of Arts in 1859, and he obtained the Fellowship of the Royal Society in 1871.

Journal of the Society of Arts.

No. 1,608. Vol. XXXII.

FRIDAY, SEPTEMBER 14, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

THE DECORATIVE TREATMENT OF METAL IN ARCHITECTURE.

By George H. Birch.

Lecture III.—Monday, April 16th, 1883.

Iron.—*(Continued).*

In contemplating the various beautiful specimens of technical skill, produced by the art of the blacksmith during the past six centuries, one cannot help feeling that it is indeed an art which appeals more to one's sympathy than many of the other finer and more manipulative metallic arts, whether they be the delicate work of the goldsmith and silversmith, or the attractive forms of bronze casting. In the blacksmith's art, the individuality which invests each specimen is due to the fact that you know that that particular object was once a shapeless mass of red-hot metal, laid upon the anvil ready to be formed and fashioned into the shape required, and that many a vigorous blow would have to be dealt, and many times would it have to be submitted to the softening influence of the glowing forge, and to be re-hammered, and cut, and turned, until shape and form were given, and it left the anvil a thing of life and beauty, telling of patience and skill, and carrying with it that genuine "ring" of the anvil and the hammer.

And this is particularly the case with English work of the 17th century. Wrought ironwork was extensively used for domestic purposes, more than it ever had been before. The great fire of London had created a revolution in house building. Timber and plaster structures had disappeared, and had made way for brick; the overhanging stories were no longer allowed, and basements had to be protected by iron railings, and the entrances to the mansions of the rich citizens, which generally were set back from the main street, were decorated with iron gates and grilles. At the more fashionable end of London, near to the Court, we find the same universal use of ironwork, in connection with the red brick and many windowed houses of the nobility and gentry; and in many cases elaborately wrought iron handrails and standards to staircases, instead of the ordinary wooden ones, gave an impetus to the art of the blacksmith, and made English work at this period to be invested with an art of its own, and peculiar to the country. The erection of a new cathedral, in the revived classic style, required that the smith's art should also be represented in its fittings and railings. Externally, the cathedral is, or was until lately, entirely surrounded by a very handsome iron railing of Sussex iron, made at Lamberhurst, and many of the smaller openings externally are filled with ornamental grilles of charming design and workmanship. Internally, the screen which separate the north and south aisles o the choir, the gates which formerly closed the choir screen, now removed further eastward, the grilles in the backs of the oak stalls and various other railings about the building, are all of them no mean specimens of the art of the blacksmith in England. Unfortunately, however, all the internal work at St. Paul's Cathedral is not thoroughly English. Although made here, it was designed by a Frenchman, a Monsieur Tijou; but I think his work is confined to the choir enclosures and does not include the smaller grilles. At Westminster Abbey, the choir gates and low screens across the north and south aisles of the nave are fine specimens of wrought work, but wanting the grace of the St. Paul's examples. Tijou is also supposed to have worked on the handrails to the state staircases at Hampton Court Palace.

Of late years we have lost a number of the finest specimens of the smith's art of this period. Lindsey-house, Lincoln's-inn-fields, called also Ancaster-house, on the west side, had very fine and curious iron grilles placed between six tall piers of the finest brickwork, surmounted by Portland stone vases: the iron-work has gone, and so have four of the piers, two giants only survive. Powis-house, in Great Ormond-street, destroyed to make Powis-place, had a similar enclosure: and Buckingham House, now Buckingham Palace, the fore-

court was surrounded by a fine iron grille. And in my own recollection, several very fine wrought-iron gates in the City have been removed and sold as old materials. Bridewell Hospital, in Bridge-street, Blackfriars, still possesses a superb pair of folding gates, the finest specimens in the City. I mentioned Great Ormond-street; you will see there to this day what our forefathers, in the early part of the 18th century, considered necessary for an area railing; and at Lord Carrington's, at the entrance at the back in Whitehall-yard, there is still remaining a fine railing and lamp posts, to which are attached the old extinguishers for links. Many of the handrails to the staircases of the houses and mansions of the 17th and 18th centuries are of wrought iron, especially at the west end of the town.

Lincoln's-inn-fields and Bloomsbury-square still retain some of the wrought-iron staircase rails. At Nos. 35 and 46, Lincoln's-inn-fields, are very fine specimens, especially at the former number. A panel on the first floor landing is one of the finest of this period to be seen anywhere. At No. 5, Bloomsbury-square, the corner house of the square and Hart-street, there is a good wrought-iron staircase rail; the house itself is interesting as being the town house of the elder Disraeli. The entrance gates to the gardens of the Honourable and Learned Societies of Gray's-inn, and the Inner Temple, are very fine specimens of the smith's work; and in the neighbourhood of London, at Hampstead, Clapham, Stoke Newington, Stratford and Bow, Kensington and elsewhere; indeed, wherever you meet with the old red brick houses with their tiled roofs and quaint dormer windows, you may be sure to find also ironwork of this period. Although I have mentioned London more particularly, the provinces are equally rich; at both the Universities you will find admirable specimens in some of the college gardens, notably at Clare College, Cambridge, and at Trinity College, Oxford, and the gates to the Clarendon Press in the same city. But the crowning glory of this particular phase of metal work is to be found at South Kensington and Bethnal-green Museums—the gates or screens which formerly adorned the gardens at Hampton Court Palace. There are twelve of them, and the graceful variety and charming design which characterises each is extraordinary. National emblems and attributes, such as the rose, thistle, and harp, are freely introduced; and the manner in which the freedom and beauty of the wreaths and scrolls, and the foliage of the acanthus, contrasts with the upright bars of the constructional lines of the gate, is beyond all praise. Purists may object to natural flowers being imitated in wrought iron, and perhaps, strictly speaking, the material has been slightly lost sight of by the talented designer of these wonderful gates; but in the exuberant fancy and exquisite taste displayed, the technical skill by which difficulties have been overcome, silences every objection, and one can look only in admiration and wonder at the superb result. Huntingdon Shaw, the blacksmith, of Nottingham, may well indeed rank first among our blacksmiths. One sees his works now naturally at a disadvantage. They require their own surroundings of prim walks and clipped yews, and the vistas through formal avenues into the shady depths and sunny expanses of the Home Park.

I have before alluded to the iron industry formerly carried on in the county of Sussex, which was at one time famous for its castings; and the present bare and denuded look of its rolling downs has been attributed to the destruction of the timber required for smelting the ore. Among the characteristic specimens produced in the county, and of which many still remain —being almost indestructible—are the cast fire-backs, and very beautiful works of art some of these are. They are generally in low relief, with armorial bearings or figure subjects taken from Biblical or classical sources. I can only regret that the extreme unwieldiness and ponderosity of even a small specimen prevents me from exhibiting any to-night. In some of the Sussex churches one often meets gravestones of cast iron, which, in their way, are as worthy of notice as the Nuremberg bronze ones.

The City churches are rich in specimens of the smith's art, which is displayed not only in fittings, such as altar rails, sword rests, and hat rails, but also in a more legitimate architectural manner, as was to be seen in the church of St. Dionis Backchurch, where the organ gallery was supported by square Corinthian pilasters, whose caps and panels were very delicately worked. The bracket supporting the font cover at St. Michael, Queenhithe, was a very quaint instance of metal work, somewhat Dutch in character. Both these churches have been lately destroyed, and their contents dispersed and sold.

Lead.

Lead, like iron, is seldom found pure, and has to be separated from its ore, which is

more often sulphur, but sometimes an oxide, and, like copper, would have attracted the attention of primitive races, not from its colour, but from its extreme weight, and the use of it accordingly goes back to very remote times. In that passage from the book of Job which I have already quoted, "graven in the rock in letters of lead for ever," shows that this peculiarity of the metal, in being so easily molten and run in a fluid state into an engraved surface, was thoroughly understood and appreciated, and probably had been made use of for countless ages previously. When that particular Pharaoh and his host were overwhelmed in the Red Sea, Moses, in his hymn of triumph, describes it as, "They sank as lead in the mighty waters;" but of its architectural use, in ancient times, I can find but few records, and those of no moment. General de Cesnola discovered a quantity of lead rolls, which looked precisely like gas-pipes, and on putting one in his pocket as an example, he was surprised to find that it had slightly unrolled; and on examination, these gas-pipes turned out to be Greek inscriptions, of which no sense could be made, inscribed on thin lead. Even in Roman times, the use is not so general as one would imagine from the easily fusible properties of the material. In those two new rooms recently opened in the British Museum, in which are collected, and most admirably arranged, all those traces of the arts and refinements of our Roman conquerors for the first four centuries of our era, you will see several bars of lead called "pigs," stamped with the name of the Cæsars; and in a case in the first room are some leaden coffins, on which are some cast ornaments of shells, lions, masks, and bead-like ornamentation, proving its use; and also at Bath, where they have lately discovered the original Roman hot bath, it appears to be lined with lead at the bottom; and as this bath is of unusual size, 80 × 40, it shows that this peculiarity of metal, both for covering and lining, was thoroughly understood; and at Pompeii, leaden pipes have been found, so that those most prosaic uses to which we, in these days, apply the same metal were applied exactly in the same manner nearly 2,000 years ago. But we have to consider "lead" in another light. "As heavy as lead," that household proverb among us. How can it be possible to invest a material seemingly so unpromising with any amount of life, or to infuse into it the quickening spirit of art? This is a question that may be reasonably enough asked now-a-days, when we confine it to lead piping, and to all the horrid paraphernalia of sanitary science; but the case was far different in the middle ages, when sanitary science was not, and typhoid stalked unknown, although lead was used often prosaically enough, it was also made a vehicle conveying an art lesson, and was impressed with a native beauty intrinsically its own.

Taking it, first, in its ordinary application as a medium for covering roofs, and more especially the roofs of large ecclesiastical buildings or civic halls, what a wonderful help to the architecture do we find in this unpromising material.

You have but to carry your mind for a moment to one of our own cathedrals—it is hardly necessary to single out any particular one—and dwell for a moment in imagination on the prospect thus conjured up. The long line of roof, of nave, and choir, and transept, broken only here and there by sunlit pinnacles, or divided by massy towers, the exquisite soft tones of that lead-covered roof, how they serve as a foil to the stonework, and, by the very deadness of their silvery grey, throw into relief statue and niche, parapet and buttress.

Observe the effects in the changing light, the transitions from solidity and depth of tone, when all around is basking in sunshine, to the moment when dark masses of heavy clouds bring the long line of roof into startling contrast of light, in comparison to the gathering gloom, so that the chattering daws, as they seek shelter from the coming storm in the nooks and crannies of the weatherbeaten stonework, seem all the blacker by the contrast.

But, apart from the use of it as a covering only, it was also ornamented, and such ornamentation was applied in strict accordance with the capabilities of the material. The ridge line was treated so as to mitigate its harshness, and was softened off by a cresting, plain and simple at first, during the 12th, 13th, and 14th centuries, but gradually, with the architecture itself, becoming more and more elaborate, until it culminated in some of those wondrous crestings of beaten and cast work which one sees in France, at Blois and Rouen, at the commencement of the Renaissance. The earlier form of ridge was generally composed of erect trefoils, cast in two pieces, and soldered together over an iron or wood support. In France they more often took the form of a fleur-de-lys. At Noyon, this fleur-de-lys is enriched on each side with a sort of cusping.

and in many instances, where another material has been used for the roofing, such as tiles or slates, in addition to the cresting, there is a sort of apron piece to cover the apex, and this is cut into long pointed strips or tongues, either straight or curved, in a flame-like form. Besides the use of lead for the covering and cresting, it was also employed to cover those quaint dormer windows which, in mediæval architecture, play such an important part in all large buildings. Here the lead was used in various different forms; both sides and roof were not only covered with it as a protection, but the construction was ornamented by the use of finials or vanes, made of wood or iron internally, and covered with lead. These crowned the summit of the dormer, while the sloping sides of the gable were adorned with crockets, in many cases cut out of sheet lead, and beaten and bossed out to the form required, round a central support to give rigidity to the whole. Many of the large cathedrals on the Continent, especially in France, possess most exquisite little spires, or, as they are called in France, "flêches." These rise at the intersection of the main roofs, and in some cases lead plays a most important part in their decoration. Could there be anything more lovely or more appropriate for its position than the exquisite flêche which surmounts Amiens Cathedral. Apart from the constructive skill displayed in the manner in which this is built, so as not to exert any undue thrust or pressure upon the roof, in itself a marvel of carpentry, its exterior oaken carved work, statues, niches, pinnacles, and traceries are covered with lead, and it is one of the most beautiful works of art which the middle ages have bequeathed to us. Unfortunately, the upper portion has suffered considerable mutilation in some clumsy repairs executed in the past century, requisite on account of its having been struck by lightning, and the upper part partially destroyed by fire. This has considerably shortened it in height; ; but in the 5th volume of Viollet Le Duc's "Architectural Dictionary," page 470, he gives a restoration of its original state, from drawings preserved. It was originally profusely painted and gilt, traces of which remain. At Paris both the Cathedral and La Sainte Chapelle have had modern leaden spires added in very recent times, replacing others which formerly existed. And at the Abbey Church at Eu, there is another flêche in which lead plays an important part, although it is not so completely covered with it as at Amiens. Old John Stow's description of that of the Austin Friars, in Broad-street, leads one to believe that it was probably a leaden flêche. He calls it "a most fine spired steeple, small, high, and straight, I have not seen the like;" and although it had suffered in a storm, 1362, had been raised again "to the beautifying of the City."

We have again in London an instance of one of these lead spires crowning the central hall of that much abused and severely criticised building, the New Law Courts, hard by in the Strand; and both for form and the ornamental treatment of the lead work, it will bear comparison with many of its mediæval prototypes. I have alluded to the use of lead in statues which adorn the spire at Amiens. Figures of angels were also introduced standing on the apex of the roofs of some of the apses of French cathedrals, and were so constructed that, by the action of the wind on their wings, they turned on their sockets, and acted as weathercocks. Monsieur de Laborde, in his notice "Des Emaux, &c., du Louvre," gives some curious information respecting these leaden statues, from which it appears that the statue was first roughly carved in wood, and then the lead was beaten over it, and then the metal was removed and soldered together, the joints being concealed by the drapery and the requisite rigidity being given by iron bars and supports inside. In the accounts of the expenses of the church of St. Maclou, Rouen, occurs the entry. "To John Pothyn, sculptor, for having carved a prophet in walnut-wood, to serve as a mould and pattern for the works in lead."

In England we had few or none of these elaborate specimens of lead work, but it was a very favourite material for covering spires. Lincoln Cathedral possessed three, surmounting the present towers, and the grouping of these on the top of the commanding eminence on which the cathedral is built, must have been particularly fine. Southwell Minster had three spires also; two of these have just been rebuilt. Hemel Hempstead has a very fine central spire of lead, and there are many others, but these English examples offer no particular decorative treatment; while, on the contrary, the French examples, as at Evreux and Notre Dame de Chalons sur Marne, are highly elaborate. At the cathedral at Evreux, the central tower is surmounted by a leaden spire of open tracery, and is a very graceful example. At Chalons the two western towers have leaden spires, and I am tempted to draw particular attention to the last mentioned example, on account of its

singularity, another metal having been pressed into the service, namely, tin. The employment of this metal, and the manner in which it was applied, shows how thoroughly the men of those times understood the science, if I might so term it, of polychromatic decoration; I would here notice that the spire of which I am speaking is the south-western one at Chalons, the companion one having been rebuilt in recent times. Gilding and painting the lead-work in patterns, although highly effective, and extensively used at this period, had been found out to be not so durable, and the expense of reinstating excessive; they therefore devised this means of decoration, not for the sake of covering up or concealing one material with another, but to add another beauty to their work, and this by means of a metal which would be safe from oxidation, and which would form an agreeable contrast with the dull tones of the lead-work by its own intrinsic brilliancy, and also possessing the further desirability of not being affected by either rain, frost, or heat. There are traces of this form of decoration on the lead work of several of the French buildings of the middle ages, but the example which I have quoted from Chalons sur Marne is the best preserved. This spire, and the process of tinning was described by the late William Burges, A.R.A. (a former Cantor lecturer in these rooms, whose lectures I had the privilege of attending), in some papers he wrote on lead work in the *Builder*, vol. xiv. (1856).

The lead which was intended to be decorated was prepared with a thick coat of lampblack and size, and the pattern traced with a point, and all that portion of the surface to be tinned was removed with a shavehook, so as to leave it clear and bright; and after being rubbed with sweet oil the solder was applied with an iron in the ordinary way. Mr. Burges further stated that at Chalons the tinning process had been applied a century after the spire had been erected, but that the usual plan was to do the tinning in the shop, before fixing the lead in position.

John Stow, in his description of the priory church of St. John of Jerusalem, at Clerkenwell, speaks of the great bell tower which had to be undermined and blown up with gunpowder by the Protector, the Duke of Somerset, to build his palace in the Strand, as being a most "curious piece of workmanship, graven, gilt, and enamelled, to the great beautifying of the City, and passing all that he had ever seen." One cannot help thinking, from the foregoing description, that its leaden roof was probably adorned with painting and gilding, and with this process of tinning, especially when you recollect the connection with this order and their brethren on the Continent, and were not at all unlikely to have introduced something of the sort in England; the church and tower had been rebuilt 1381, after the disastrous fire occasioned by the rebels under Cade and Tyler. I think it is more likely to have been this than ceramic decoration.

Lead was sometimes, in the middle ages, used, as the Book of Job describes, "letters of lead in the rock;" in other words, run into incised lines in marble. In the church of St. Rèmi, at Rheims, is a pavement of this description; and at the Duomo, at Pisa, it was principally used for figure subjects, but more commonly for inscriptions, monumental or dedicatory.

I need only allude in the briefest way to one of its architectural uses, to the importance given to the metal in glazing, and of the many thousand examples of the richest stained glass whose gem-like colours are outlined in lead; or in other cases where the lead lines themselves form the pattern, the glazing being of plain glass. At Ewhurst, in a room in a farm-house used as a dairy, is a quaint example of a ventilator, which occurs in the diamond quarry glazing, and is cut out of sheet lead. There are examples in France during the 13th and 14th centuries, where lead was employed in not quite so legitimate a manner, and those are where the lead has been bossed and hammered so as to represent carved stone capitals, and applied to the columns, and on being painted could scarcely be distinguished from stone.

To what perfection the French plumbers arrived, can be seen from studying some of those truly exquisite finials which abound in France, not only on the Cathedrals of Chartres, Rouen, and Amiens, but also on the civic buildings at Nevers, Bourges, Hotel Cluny, Palais de Justice Rouen, Hotel Bourgthéroude, and the Royal Chateaux at Blois, Chambord, Amboise, and on many of the Chateaux belonging to the noblesse. Lead was also employed for fonts, both in Germany, France, and England. I believe we have over twenty-two examples here, but nearly all 12th century; at Brookland, in Kent, is a cast leaden font, arcaded with the signs of the zodiac, and the labours of the months introduced. As one would naturally imagine, the same pattern does duty over and over again. In France there is a fine leaden font at

Berneuil, and another at Lombez, which is curious as being in two divisions or bands, the lower one having figures in relief standing in quatrefoil panels, four models only being used for the whole sixteen figures; and the upper band has a hunting scene, which is also repeated four times. But the richest of these leaden fonts is in the Cathedral at Mayence; the date of it is 1328, and has been richly gilt.

Leaden fountains are common enough on the Continent, but there are three, each of a very different design and date, in three different countries, which deserve to be noticed. The earliest of the three is at Brunswick (some say that this is of pewter, and not lead). It is in three principal divisions, each consisting of a basin of lead, whose exteriors are ornamented with reliefs of shields, scrolls, little seated figures between buttresses and lions' heads from which the water proceeds. The upper basin is surmounted by a seated figure of the Madonna with the Infant Saviour, under a light and elegant canopy of open tracery, with a gilded vane at the apex. The next is at Guingamp, Finisterre, Brittany. It was reconstructed in the 18th century, by Corlay, but I fancy that he only re-worked and added to the earlier fountain, which was constructed during the life-time of Anne, of Brittany; And the third is at Vienna, in the Neumarkt. This represents the Danube and its tributaries. the four figures round the base are very beautifully cast.

This fashion of casting statues in lead became very general. Many of the figures which adorn the gardens and fountains at Versailles are of lead. In London we have two, the very graceful kneeling figure of a blackamoor supporting a sun dial in the garden of Clement's-inn, and the statue of Shakespeare which surmounts the hideous portico of Drury-lane Theatre; this has been painted in stone colour. Old Buckingham and Montague houses were adorned with statues, which I think must have been of lead, more especially the former.

I think no one ever appreciated the capabilities of lead as an architectural ornament better than Sir Christopher Wren. Taking St. Paul's Cathedral as the first instance, how pleasing is the contrast between the carefully considered curves of that lead covered dome, and the Portland stone of which the building is constructed, and how superior that material is for effect, compared to a stone dome? You know the extraordinary effect of light and shade on the exterior of St. Paul's, due to weather and the presence of what is now discovered to be a fungoid growth, and not altogether dirt and smoke, as one would imagine. Fancy how very disastrous, and subversive of the present grand effect, if the same had been carried out in the dome, and you had one side of it as black as your hat, and the other almost as white as snow. How vastly superior is that lead covering, with its ribbed panels carrying up the architectural lines to the stone lantern and the golden cross on the summit. The same careful study of this peculiar fitness may be seen also in Wren's many towers and spires; and he had evidently a predilection for lead, for out of the thirty-one spires which he built in London alone, twenty-two were of lead, of which nineteen still remain, three having been lately removed. Time will not permit me to do more than briefly notice the superb proportions and fine effect of St. Margaret Pattens in Rood-lane, the stately effect of St. Laurence Jewry, or the graceful contrast of the leaden spire of St. Martin's, Ludgate, and the grand mass of the cathedral behind it, serving as it does as such an excellent foil to the latter, and giving scale to its immensity. But alas! one of the finest effects of this little elegant spire, looking up the curved ascent of Ludgate-hill, has been for ever ruined by the erection of that horrible railway bridge, bristling with griffins' wings, which was allowed to be thrown across the foot of Ludgate-hill; and I suppose it will not be long before the spire itself will be removed under the provisions of that Act "for providing relief for lazy parsons," otherwise the Union of Benefices Act.

Among many other instances of the artistic treatment of lead in the 17th and 18th centuries, I would instance the leaden cisterns, very few of which now remain. One of the finest that I know of is to be found at one of of the canonries in Amen-court. The ornamentation on these is sometimes very rich. Some of the rain-water pipe-heads are also deserving of notice, and show that even the plumber's occupation could be elevated to the position of a positive art.

Zinc and its use in architecture is a subject almost unnecessary to dwell on. It may be used advantageously abroad, but it does not seem to stand our peculiar London atmosphere; but in internal work, alloyed with other metals, it becomes a very useful medium, especially with copper, to form brass, and in that form is used in many ways. Some few years ago, zinc was largely used for ornamenting ridges and dormers, and terminations to roofs;

but the difficulty of allowing for expansion and contraction from variations of temperature is always very great.

Most of our modern bronze statues are, to a certain extent, alloyed with zinc, and it is to this cause that we must attribute their black and grimy appearance. I believe the reason for using it is, that it enables the copper to become more readily fusible, and to run more easily; but if it really deteriorates from the imperishable qualities of bronze, its use is regrettable. I am anxious to hear the result of the examination of the well-known figure of Achilles at Apsley House. But we have a slight consolation in knowing that our neighbours on the Continent are no better off. The large equestrian statue of Frederick William at Cologne, and some very recent statues at Berlin, have gone very black. One of the alloys, exhibited here to-night, and to which the fancy name of "Delta" is given, seems, so far, to be an improvement on brass, in certain positions, from its extreme hardness, although, in appearance and colour, there is very little difference.

I have now, so far as I have been able, demonstrated to you how these metals of gold, silver, copper, tin, iron, and lead, have been used in connection with architecture, from the earliest known examples of it to comparatively recent times, and I have endeavoured to show what an important part they have always taken in its ornamentation, and how, with regard to the precious ones, it would be absurd to suppose that on account of the immense increase of the inhabitants of this world ,they could be ever again applied in the same way that they were by the Egyptians, Assyrians, Persians, Jews, or other ancient races. Ordinary currency would naturally absorb the bulk of them; and to adorn buildings in these days with solid plates of gold and silver would be an anomaly, besides being almost an impossibility. It is true we can "overlay our building with fine gold," very fine gold, in the shape of ordinary gilding, an ornamentation whether applied in connection with painted decoration or not, is always effective and harmonious, and sometimes most important in accentuating particular lines or portions of the architecture. It requires skillful handling, as there is the possibility of over-gilding. The Albert Memorial at Kensington is often quoted as an example of this, especially with regard to the seated statue of the Prince Consort, but I think that there was a wise discretion exercised in gilding this; we all know what a funereal and lugubrious look our out-of-door bronze statues assume, and to have had a black heavy lump as the central figure in the midst of all that truly beautiful sculpture, would, sooner or later, have proved a great mistake; if it is possible to bring an objection against the use of gold in that superb monument, it is to be found, I think, rather in the contrast of the glassy, garish look of the gold mosaic backgrounds in the upper part of the canopy, the eye being at once attracted to them, by the startling effect produced by reflected light destroying the repose of the lower part of the monument; but this objection, I am bound to admit, only exists when the rays of light are horizontal—the mosaics do not always present this appearance. Another building whose exterior is profusely adorned with gilding, is the dome of the church of the "Invalides," at Paris, and to see this from any of the upper windows in the Rue Rivoli, across the sea of foliage of the gardens of the Tuileries, standing out in that peculiar clear atmosphere of Paris, with the hazy outline of the hills by Meudon and Clamart as a background, is a beautiful sight, either in the early morning, when it is the first to catch the rays of the rising sun, or when it glows in all its full golden glory before the declining orb sinks behind the hills of St. Cloud. This gilded decoration has been called vulgar by some, and admiring it lays one open to the charge of vulgarity; but I would even still farther dare to suggest that I should like to see the ribs which accentuate the lead work of the dome of St. Paul's treated in the same manner, so as to carry up the eye to the golden gallery, and ball, and cross, not to the same lavish extent as gilding has been applied to the dome of the Invalides, which is only half the size, but confining it to the ribs only.

The scheme for the adornment of St. Paul's, which was adopted by the majority of the heterogenous committee to whom, unfortunately, the subject was referred by the Dean and Chapter, thoroughly recognised this principle of brightness and light, by the employment of gold mosaics, knowing the value of reflected light in a building whose interior is naturally gloomy. Mr. Burges's idea was to have covered the whole of the interior surfaces with materials such as polished white and coloured marbles, burnished bronze decorations, and paintings executed in majolica, nothing was to be employed that could not stand the application of soap and water when required,

and the leading tones were to be white and gold. Unfortunately, the storm of criticism raised by such a daring scheme, and further provoked by the exhibition of a small model, where no allowance could possibly be made for the distance and atmospheric effects which would have been observable in the building itself, utterly condemned it. The press were for once almost unanimous in their disapproval, and the general public kept their money in their pockets, only £40,000 being subscribed towards what would have cost probably ten times as much.

One marked feature of this scheme was the employment of bronze, gilded; all the panels under the windows were to be filled with bronze memorial bas-reliefs or subjects from the Bible, and would have presented an appearance similar to some of those Italian churches whose superb interiors are at the same time both our envy and admiration.

Whatever may be the opinion respecting the use of bronze in London, one cannot help hoping that justice will yet be done to a material so easily manipulated, and so durable in its substance. I say "justice," because our many attempts, with but few exceptions, have been simply caricatures and hideous travesties. With the best of intentions, we certainly are most unfortunate. If you will take only a few examples of where bronze has been largely employed in decorative sculpture, in the approach to the City from Holborn, you are first confronted with an equestrian figure, which from a very short distance looks as if it had two heads; on a nearer approach it appears to represent the late Prince Consort taking off his hat to the City, and the juxta-position of the cocked hat and the real head are most unfortunate. Below, on the granite pedestal, on very slender perches, and on which they seem to have considerable difficulty in maintaining their position, are two most extraordinary looking little females, allegorical of something. One looks like a school-girl who has just done a sum to her satisfaction. A few steps further, and we arrive at the Viaduct; and the first impression is that the Euston-road and its statues have come down here for change of air, and that necks and legs have been served out promiscuously; and then you have the usual garnish of griffins and spikey wings to fill up odd corners. And having passed this fearful Scylla, you come to Charybdis in the heart of the City. In that portion which would be the forum, the very centre of mercantile life, you have, very properly, more statues, one of a very benevolent gentleman, without a hat, seated in a comfortable arm chair, and inspecting at his leisure a scantily dressed stone lady, completely doubled up and crushed into a sort of bronze kiosk much too small for her; while a third commonplace looking gentleman, also without a hat, turns his back on this interesting family group, and makes some important memorandum, either in a betting-book or pocket-book—it might do for either. And when you finally leave all these horrors behind you, and set out again westward, you will meet, not a lion in your path, but something more terrible, and which requires to be supported by statues of the reigning Sovereign and the Heir Apparent, evidently to give "it" an air of respectability, and to prove that it really is not what it looks like, or what, perhaps, it might be taken for. At Trafalgar-square, you find the culminating point of these grimy horrors, scarcely to be redeemed by the monumental lions round the base of the Nelson column, and which are supposed to be bronze. Charles I. may well turn his back upon it all, and decline to have anything to do with it. If you had chosen the Embankment you would have fared worse. The same commonplace statues; the obelisk with its bronze decorations and attendant sphinxes, inscribed with the cartouche of a Rameses who knew them not; and finally, the Outram statue, and its granite pedestal decorated with bronze in the style of coffin-plate furniture.

The judicious use of iron grilles or railings, either surrounding or partly protecting large public buildings, is in itself undoubtedly a great help to the architecture, and more especially when such an enclosure or railing partakes somewhat of the character of the building it protects. In London, we have one or two examples of where the iron railings, apart from their intrinsic beauty of design, do lend themselves to enhance the architectural design. For example, the handsome and massive railing round St. Paul's Cathedral, to which I have already referred as a specimen of cast work; the small dwarf railing in the Strand front of Somerset House, in a more limited form; and among modern buildings, the new Law Courts, with its various grilles, gates, and hinges; and the large block of red brick buildings at the corner of Carey-street and Serle-street, called New Court-chambers. In both these buildings, and in many others of recent date, this valuable adjunct has been carefully considered and studied, more especially by the talented designers to whom we are indebted for these

additions to the architectural beauties of our metropolis, Mr. Alfred Waterhouse, R.A., and the late George Edmund Street, R.A.

It is a matter for great regret that the vast sums of money expended upon the railings and gates of the British Museum, the Houses of Parliament, Buckingham Palace, and the Embankment-gardens were not productive of something more artistic. The first example which I quoted, the railings in front of the British Museum, from their extreme heaviness and mass, and the profusion of chocolate paint and gilding, only makes the dark and forbidding pile of building behind look more gloomy and severe from the contrast. I believe that one of the reasons which made the authorities select a railing at once both massive and high, was the additional security in case of popular emeutes, but they have certainly erred on the side of excessive strength and waste of material. It would have been far preferable to have had a continuous granite stylobate, a little higher than the present one, with frequent pedestals or piers for statues of some of the eminent literary, learned, or artistic worthies whose works are contained within the walls of the building, and between each of the piers a bronze railing or grille, simple, but severe, in keeping with the Greek building behind. In front of the present railing, some four or five feet in advance, is a small defence or boundary of simple bars and standards, surmounted by the most charming little seated lions. These are singularly appropriate, and thoroughly in keeping with the pure Greek architecture. I forget who it was that designed them, or whether they were modelled from the antique, but they certainly deserve the highest commendation.*

The next example, the new inclosure railing round Palace-yard, at the Houses of Parliament, has the same faults. Here, evidently, the idea was to produce a railing in keeping with the architectural surroundings, and all honour to the sentiment; but here the profusion of painting and gilding only draws attention to a design which is both heavy and pretentious; the material seems to be lost sight of completely, and the principles which should actuate design, in either cast or wrought ironwork, completely ignored. It is true that an architectural precedent might be cited for this peculiar treatment, in the example of the brass or latten gates, and the enclosure round the tomb of Henry VII., in the adjoining chapel at the Abbey opposite, but I contend that the precedent does not apply. In the first place, the material of one is cast bronze or brass, intended to be internal, and in a comparatively small building, and whose destination was purely monumental, and where heraldic devices were not only appropriate, but where one would expect to find them, although heraldry is a little overdone, as one would naturally expect to find in a family who, after all, were nothing more than parvenus, their claim to the throne being derived purely from matrimonial connections. Then what have the Tudor badges and devices to do with a railing in these days? A railing which, after all, encloses a yard seemingly for the mutual benefit of Hansom cabs and pigeons. As to the railing enclosing Buckingham Palace, one would have looked for a handsome termination or division between the historic Mall, remembering the traditions of Hampton Court or old Buckingham House, with its metal statues and grilles; but instead we find the embodiment of the most common-place mediocrity, railing off a space which is not even turfed, much less laid out, as it should be, as an ornamental Italian garden. And now I have one more example, and that a very terrible one, because, with the best of intentions, the result is most unfortunate. I mean the railing of the Embankment-gardens. Now this, from its very position, ought to have played a most important part in the composition of the whole design. But what have we? A cast iron railing. There is no possible objection to that; cast iron is as capable of artistic treatment as wrought, as you may see and judge for yourselves in those superb castings downstairs, kindly exhibited by the Coalbrook-dale Company. A cast iron railing is a necessity; but here we find a cast iron railing utterly unsuited for the purpose, a series of minutely designed panels, perfectly invisible even from a very short distance off, from their very intricacy and monotony of effect.

I have but little doubt that when, in the first instance, a wooden model, nicely painted, was submitted to those gentlemen whose names are so little known to the few millions or so who pay taxes for them to spend in matters of utility and artistic embellishment, they one and all thought it very "pretty," and that it would do "nicely." If they only could have seen the effect of it.

But although I may fail, and many others with me, to appreciate this ornate example of

*Since this was written I have ascertained that the merit of these small seated lions is due to the late Alfred Stevens, the sculptor.

brittle cast iron, there are others who evidently are of a very different opinion, and seem very anxious to obtain specimens of these cast panels, and with a judicious tap or two, scientifically applied, to be able to remove portions, I suppose, in order to study their beauties in the quiet and retirement of their own homes. Indeed, to such an extent is this appreciation carried, that I would seriously suggest that the authorities in Spring-gardens should deposit in some popular museum, such as that well-known one in Baker-street, a perfect specimen of one of these panels, so that future generations might see what the pattern originally was. The idea of a railing in this position is not a happy one. Standing anywhere above, either at the top of the steps at Westminster-bridge, or on the footway of the railway bridge, and looking down on the graceful sweep of the embankment, the want of the second line of demarcation is painfully apparent, a demarcation which would have been so well defined, had a dwarf stone or granite wall, surmounted either by a stone balustrade, or perhaps, what would be better, a dwarf iron grille, between frequent piers or pedestals, to break the monotony; and these might, in the course of a few generations—when the Art-culture of the present one begins to make itself felt, and we can safely indulge in statues, and not caricatures, of our heroes and worthies—be surmounted by such memorials; a far better position than that already provided for them on the edge of the "silver Thames." We have instances in London which we need not be ashamed of—and modern ones, too—that the spirit of rightly appreciating the eternal fitness of things is not wholly defunct. At Holland-house, Kensington, the monotony of the iron railings dividing the park from the main road is agreeably broken by a very beautifully designed wrought-iron grille or screen, thoroughly in keeping with the traditions of that famous old house, built by Sir Walter Cope, and subsequently the home of the families of Rich and Fox, Lords Holland; it was designed by one who, for the sake of art in the 19th century, "should have died hereafter," Mr. Thomas Jekyll, who was one of the first again to put into active practice the principles which actuated the smiths of the 17th and 18th centuries. And another example, from the design of a living architect, equally as appropriate for the position they occupy, are the entrance gates to the College of Minor Canons of St. Paul's Cathedral, in Warwick-lane, Newgate-street, and the grille filling the interval between the top of the arch and the panelled wooden doors of the gatehouse, and the entrance gates to the hall of Leathersellers' Company in Great St. Helens, by Messrs. Gardner both are protests against the chocolate and gold cast-iron abominations which have been hitherto so rife. This use of wrought iron is one which is becoming daily more thoroughly appreciated; and when one looks at these various beautiful objects for every day use, which Messrs. Gardner have so liberally and kindly lent to illustrate the decorative qualities of wrought iron, and how it can be applied not only for architectural uses, but also for domestic purposes, and how vastly superior such a material is compared to the various lacquered compositions which Birmingham turns out by the million, needs no comment; the result speaks for itself. An instance of their work can be seen in the bracket which supports the lamp above the outer door of these premises, which I, in my ignorance, took to be genuine old work, and was very surprised to hear only this very day that it was modern, and made by Messrs. Gardner. Exhibited here are also a balcony grille and little iron bracket for candles, lent by Sydney and Charles Phelps of Sidney Sussex College, Cambridge; these show that, even in the classic groves of Alma Mater, the spirit of the ancient blacksmith which produced the past glories of Clare and Trinity, were not dead, and that there was still sparks left in the almost extinct ashes of the forge, which only wanted a breath to start them again in their upward course and produce such works as these exhibited.

I can only wish that the same progressive spirit may be infused into our street lamps for an ordinary street lamp is generally a thing to be shuddered at; it is difficult to conceive anything uglier or less appropriate for the use intended. Some little time since, attempts were made to improve the upright standards or posts, but lately we seem to have again retrograded, and the more extended use of electricity having forced the gas authorities to give us a little better light, they have inflicted upon us, as a mild revenge, some very dreadful monstrosities. The lantern, or glass shade has become of an immense size, out of all proportion to the iron support, and it starts from it in the most awkward and ungainly manner possible. Four little broken-kneed arrangements carry the iron frame of the glass lantern, giving an air of weakness and in

security to the very point where strength is required, and they are weak, not only in appearance but in reality; for no sooner does a cab come in collision, but like Robert Stephenson's "coo," it is bad for the lamp. The arrangement is also productive of obscuring a portion of the light, for very often the darkest place is immediately underneath. I expect in time we shall find that the best arrangement, especially with regard to street lamps, is to make them project by means of ornamental brackets; and what an opportunity for wrought iron! We could not, of course, dispense with the standard lights. In all cases the centre of wide open spaces require to be specially lighted, but when electricity, as an illuminating power, becomes developed in the same progressive way as gas has been, I have but little doubt it will create a revolution with regard to street lamps, and suspension will be the order of the day.

I have not dwelt upon steel or improved iron, notwithstanding the immense improvements which have been effected of late years by the Bessemer and Siemens processes. I quite feel with regard to it, that, admirable as it is, and likely to supplant cast iron in its constructive application, it will not be likely to be used very much in a decorative way, wrought iron being the natural treatment; but it is too early yet to predict its full capabilities. One may say, to paraphrase a saying of a great statesman now departed, as to steel, "steel has a future."

It is said "we learn from experience;" but experience, time after time, seems to be set on one side when monetary considerations have to be considered. Although fire after fire has taken place in the metropolis, and taught us many a bitter lesson, we still go on building huge piles, storeys high, resting on a a few cast-iron girders and columns on the ground floor, or immense frontages of stone and brick, laden with columns, and friezes, and huge cornices, carried perhaps by a single girder from wall to wall, and we are told that in these days space is valuable. No matter if it does cost a few firemen's lives in the course of the year, a generous public will make it up to their widows and families, and there is no loss; the stock was last year's, and the insurance covers everything, and the business is carried on temporarily until new premises are built. We have had Building Acts enacted to lay down authoritatively the thickness of walls and the depth of footings, but none to prevent the misuse of metal girders and slender cast-iron columns. A fire has but to break out, and lap those supports in its fiery embrace, and down comes the superstructure, and the result is utter ruin and loss of life. When Paris was enveloped in flames, kindled by the Commune, and many of its finest buildings reduced to blackened and empty shells, one could trace the havoc caused by the fall of girders, in many cases worse than the ravages of the fire itself.

An instance of the decorative treatment of girders can be seen to advantage in Westminster-bridge, which, although a little weak in appearance in the crown of the arch, is far in advance of its more showy neighbour at Blackfriars. Although this is some years later than the first, it is one of the worst, the enormous dwarfed granite columns and carved caps supporting nothing, and the utterly commonplace appearance of the chocolate girders and gilded ornaments. Southwark-bridge, earlier than both, is by far the finest for repose and sober treatment.

I have, in these lectures, endeavoured to put before you the decorative treatment of the metals, and how this decorative treatment has been applied in all ages, and by nearly all people, to their architecture. I am conscious that there are many points which I have not touched upon, but I think the lessons which we can learn from the history of the past are not few. One of the most remarkable is that, after a lapse of nearly 3,000 years, history is confirmed, and doubtful points cleared up by the discovery of the bronze decorations of the gates of Shalmaneser at Ballawat. If these had been of gold and silver, we should have had nothing left of them; and had they been of iron, not a trace would time and oxidisation have left; but because they were executed in imperishable bronze, they survive to tell the tale of nations dead and buried long ago.

In my foregoing remarks I have endeavoured to introduce you to creations which the very soul of beauty has selected for her home, beauties very often not dependent on merely superadded ornamentation, but the essential and positive element of the intrinsic beauty of original design, and I have dwelt upon the manner in which each metal was characteristically dealt with, whether in the more elaborate and delicate fashion that the precious metals demanded, the delicate finish and high relief of bronze casting, or the vigorous life-like energy of blacksmiths' work. I have not read to you many of the technical parts

of my lectures, which dealt with the various processes by which metals can be ornamented or alloyed, thinking that should these Cantor lectures be printed in the *Journal*, the details could then be given. In conclusion, let me trust I have made this course as interesting as the subject of the "Decorative Treatment of the Metals in Architecture" will allow of.

General Notes.

Exhibition of Pumping Apparatus at Cagliari.—A new edition of the prospectus of the international competition of machines and apparatus for raising water, to be held at Cagliari in November next, has been received from the Foreign-office through the Science and Art Department. Copies can be obtained on application to the Secretary of the Society of Arts.

Tea Culture in the United States.—Many experiments have recently been made in the cultivation of the tea plant in the United States, and generally, it is said, with excellent results. In California, the plant has been cultivated with considerable success. The difficulties which the tea-planter has to overcome are not insurmountable, and the United States *Economist* considers that it is an industry which might very profitably be carried on in the South. It requires but a small outlay of capital and a small quantity of land. In the tea districts of Japan there are but few agriculturists who devote themselves exclusively to tea culture; the growth is generally confined to nooks and corners which cannot be very easily used in any other branch of agriculture. The indications, both in the older systems of culture in Oriental lands and in the experiments of America, go to prove that the business may be profitably pursued as a supplement to other agricultural enterprises. Each farmer may raise enough for his domestic consumption, for ten or twelve trees will furnish enough tea to meet the wants of a family of eight persons. There has not yet been witnessed enough of the tea production to judge of its ultimate results as an industry. Besides this, the price of labour, the high tariff duties, and the cost of transportation, are all to be taken into consideration in estimating the efficiency of a tea industry as a separate branch of agriculture; but the labour to cultivate a few tea plants would only absorb the odds and ends of a farmer's time, which might otherwise go to waste, and the feasibility of this has been proved. In different portions of the United States the healthy and promising growth of plants has been secured.

Channel Tunnel.—The report of the general meeting of the Submarine Continental Railway Company, held on the 17th August last, has been published. Appended to the report of the meeting is the report which the Marquis of Lansdowne prepared, as a member of the joint committee of the two Houses of Parliament, but which was not accepted by the committee. Lord Lansdowne enters very fully into the question of the commercial advantages that may be expected to result in the event of the tunnel being completed. The following are some of the paragraphs of the report in which these advantages are set forth:—"We express with confidence our opinion that it would be reasonable to anticipate an immense development of the passenger traffic." "The number of persons now crossing the Channel is, if we bear in mind the extent to which the population of the British Islands is connected by business and other ties with that of the Continent of Europe, remarkably small. The total passenger traffic between England and the Continent during the year 1882 is represented by a total of 464,000 journeys between English ports and Calais, Boulogne, and Havre, and 50,000 journeys between English and Belgian ports." "Further improvements in the harbours, and in the vessels used, would, no doubt, lead to a further increase; but we are of opinion that any route depending upon a sea passage must continue to be to some extent affected by those accidents of wind and weather, which at present render the passage of the Channel so distasteful to travellers, and which accounts for the remarkable fluctuations in the number of persons crossing it from time to time." "We cannot doubt that the tunnel, once opened, would not only afford a profitable and expeditious route for the conveyance of a portion of the goods traffic already in existence, but would lead to a large expansion of the trade between this country and the Continent. We share the belief expressed, almost unanimously, by the witnesses who have appeared before us as representatives of various commercial interests in this country, that the introduction of improved facilities for communication between one country, or one district, and another, has invariably led, if not to the creation of new trades and new industries, at all events to a development, often far in excess of the most sanguine expectations, of those already in existence."

Correction.—The statement in last week's *Journal* (p. 956) that the late Mr. Cromwell Varley held the office of chief engineer and electrician to the Electric and International Telegraph Company *until* the taking over of the telegraphs by Government, is incorrect, as Mr. R. S. Culley was appointed chief engineer in 1866, and on the transfer of the telegraphs to the State, early in 1870, was then appointed engineer-in-chief to the Post-office.

Journal of the Society of Arts.

No. 1,609. Vol. XXXII.

FRIDAY, SEPTEMBER 21, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Miscellaneous.

THE HISTORY OF THE PIANOFORTE.

The following is an appendix to Mr. A. J. Hipkins's paper, read March 7th, 1883 (see *ante*, p. 397), with corrections:—

The analysis of my paper, by Mr. Victor Mahillon, while occupied with the French translation of it, has shown the necessity of further revision than was possible at the time of publication. The most important correction occurs first, at p. 397*a*, line 40, &c.—"Now if the string be struck upon a loop." The statement thus introduced must be brought into agreement with Thomas Young's law which I had, for the moment, overlooked. According to this law, a stretched string set in vibration by percussion, or otherwise, loses, if the disturbance takes place upon a nodal division, not only the harmonic proper to that node, but all the harmonics which have a node corresponding to the same point. The usual striking place in a piano being on or near one of the most important nodal divisions, either the eighth or the ninth, it results that augmentation of intensity may be attributed to the greater amplitude and vibrating energy of the larger segment of the string produced by the suppression of the harmonic proper to the node. As to the relative value of the different harmonic divisions arising from the varying position of the point of disturbance, the first division, that of the octave, which takes place at the half of the string, and completely annuls the even series of harmonics, engenders a *timbre*, or sound quality, resembling that of the clarinet, fuller and richer than any other to be obtained from the instrument. The next best measurements, tried dulcimer fashion with a suitable hammer, are those which correspond to the third, fourth, sixth, and eighth of the string. Of all these, the last division only, from obvious reasons of construction, is possible in a pianoforte. The fifth and seventh are less favourable than the third or fourth. At the ninth, the quality of tone becomes harder, as the tone regulator well knows. This tendency increases in proportion with the diminution of the division for the striking place, until the oboe quality is attained, due to the favouring of the very high harmonics at the expense of the deeper. The "lute" stop of a harpsichord with the quill plectrum acting close to the bridge, might be appropriately called the "oboe" stop, from this peculiar nasal quality.

While harpsichords and spinets had their strings agitated mechanically, at distances varying between a fourth and a seventh, I have not myself met with an example of a grand pianoforte struck so low down even as the seventh. In Broadwood's grand pianos, now struck exactly at the eighth, the seventh and ninth harmonics are distinctly audible, while the eighth is obliterated; the force of the blow at the eighth division does not therefore annul the neighbouring harmonics—that is to say, the seventh and the ninth. In old spinets and harpsichords no attention was paid to the point of disturbance, although we find the younger Hans Ruckers obtaining a modification in quality by using two registers of crow-quill *plectra* on one string. His nephew, Jan Couchet, went further with this idea of varying lengths of string and striking place, an idea which Huygens fostered ("Jongbloet and Land's Collection of Huygens' Musical Correspondence"). In the grand pianoforte, John Broadwood's division of the sound-board bridge rendered a more favourable striking-place for the bass strings possible. I believe John Broadwood was the first to carry out, in grand and square pianos, the idea of a rational striking distance. A few years later (A.D. 1800) Young formulated his law, already referred to. Kützing ("Das Wissenschaftliche der Fortepiano Baukunst." Berne, 1844) was subsequently empirically enabled to assert that the best quality was obtained in a pianoforte at the eighth of the string, without having recourse to a softening of the hammer covering—indispensable when the blow was directed to the ninth. From what precedes it may be asserted that there is no foundation whatever for the current notion, which Helmholtz has reproduced, that pianoforte makers have sought the seventh or ninth of the string, in order to banish one of those comparatively dissonant harmonics, and leave the concordant eighth to form part of the harmonic sheaf combined in the note. Where they have used the ninth, and even shorter divisions—as has been customary in the trebles—it has been done, without theory, to gain a more brilliant effect.

Page 397*b*, line 23, &c., "has been called the soul," should be "may be called the nervous system." I have made inquiry about the wood used in America for pianoforte sound-boards, and learn from Mr. Dolge, who is a practical authority, that it is the *Abies alba*, a wood of rather softer texture than the European *Abies excelsa*, the spruce, which includes the *Haselfichte* of the Bavarian highlands, used in the best fiddle making.

Page 399*a*, line 29, &c., "Cristofori cut a notch in the butt of his hammer;" to be accurate, "formed a notch upon the butt." In practice it comes to the same thing.

Page 399*b*, line 23, Cristofori "retained the equidistant harpsichord scale;" not exactly, as the harpsichord has not an apparent equal distance between each string, while Cristofori's (and Silbermann's) pianos have. This correction applies also to p. 400*a*, line 23.

Page 400*b*, line 3, for "keyboard" read "soundboard;" and line 5, "Friederici of Gera;" the acquisition, since my paper was read, by Mr. Victor Mahillon, of an upright grand piano by this maker, dated 1745, corrects my information as to date; moreover, on this instrument he inscribed his name Frederici. The mechanism of this upright grand piano is very simple, the hammer action resembling that German clock-bell action, which Mr. Mahillon, having seen another example at Nuremberg, suggests, may have been transferred to the piano; of course, independent of Cristofori's invention, to which it would be mechanically inferior.

Page 401*b*, line 4—Nannette Stein's six pedals are thus arranged, beginning from the left foot:—1, shift pedal; 2, bassoon; 3, damper; 4, half-celeste; 5, full celeste; 6, drum. Steibelt "Methode de Piano" (Paris, 1805), describes the first four pedals only, and gives signs for their employment.

Page 402*b*, line 19—For "right foot pedal" read "left foot pedal;" line 27, &c., dele "reflected," and "through the bridge," the strings being sensitive to each other.

Page 403*a*, line 9, &c.—For the same reason, dele "by excitement from the soundboard carried through the bridge." This excitement is carried through the bridge, which certainly reflects vibration, but that is not the only cause of sympathetic sounds, as the reader might, were this statement left unqualified, suppose.

Page 402*b*, line 41, &c.—The treble dampers were first omitted in grand pianos about 1809. In the original square pianos of Zumpe, the dampers were used throughout. In John Broadwood's square piano of 1780 one note is left undamped, the highest. In 1792 he had the eight highest notes undamped in a similar instrument. Evidently to gain "ring," as with his brass damper it was not a question of convenience.

Page 403*b*, line 44—The Lyre pedal was introduced in its first form in 1809-10.

Page 406*a*, line 18—"Tomkisson," wherever this name occurs, read "Tomkinson."

Page 407*a*, line 40—I find Hawkins was living at Philadelphia, United States America, when in 1800, he took out his patents in his native country, England, and in America.

THE FISHERIES EXHIBITION.

No. III.

The variety of nets exhibited at South Kensington is so great that allusion can only briefly be made to those most in use by British fishermen, and to one or two which seem to be very efficacious in foreign fisheries.

After the trawl-net, already described, the drift-net is the most important factor in the British fisherman's operations. It is by the drift-net that most of the herrings are caught round our coasts; but it is used also for pilchards, and captures mackerel and some few other fish which swim near the surface of the sea, and at no very great distance from the shore. As its name implies, a drift-net is allowed to drift, not being towed or fixed in any precise space of water, but travelling along with the tide. The meshes in a drift-net vary according to the fish expected, whether mackerel, herrings, or pilchards, and they are caught by their heads passing through the meshes, which afterwards slip under their gill-covers when they open them to breathe. The drift-nets, of either cotton or hemp, are made in "pieces" of 60 yards long, and about 9 yards deep, and each net is 30 yards long. When fastened together, end to end, they are called a "train," "fleet," or "drift" of nets, and extend considerably over a mile in length. Fifty years ago, a fleet of English herring nets varied from 61 to 91 (odd numbers being preferred), but now a fleet means 101 to 181. The French, whose boats are larger than ours, frequently "shoot" at one time as many as 280 nets, which would stretch something like three miles. It has been calculated that there are often 10,000 miles length of nets at work in the North Sea at one time.

The nets form a perpendicular wall of meshwork, which is partly supported by corks along the rope on the top edge. But as it is found that the fish sometimes swim lower than at other times, the nets, which are heavy enough to sink even with corks attached, are further buoyed up by small kegs, called "bowls," one of which is attached by a rope to each piece of net. By means of these ropes the nets can be let down some fathoms, or held up near the surface. The "warp" is a stout rope, to which each net is made fast by two small ropes called "seizings," and by this the hauling in of the nets is accomplished. The fishing is always carried on at night, and hence it often happens that the nets are interfered with by passing vessels or trawlers. The nets are shot about sunset, great care being taken in this operation that they fall in the right position, and that the "seizings" are made fast to the warp at their proper intervals. The length of the warp is then arranged so that there is a sufficient strain on the nets to keep them fairly straight, according to the state of the tide, wind, and weather. The boat's head is brought round to the wind, the foremast lowered, the sails taken in, except a small mizen sail; the regulation lights are set to show the boat is fishing, and the "drifting" proceeds. Some of the crew now take a little rest; but from time to time the warp is drawn in, so that the first net may be examined to see whether many fish have "struck." When there are sufficient indications that the time has come, the hauling in commences, by aid of the "capstan," and all the crew are very

busy, each hand having his allotted place, like men-of-war's men at the moment of action.

The herring season round the coast of the United Kingdom may be roughly stated as comprising the latter half of the year, but it varies in different districts, as the shoals of fish move from one to another, or, as the best authorities now seem to think, as the fish come up from the deeper water, according to the changes in the temperature. On the Scotch coasts, the main fishing begins in July, and at Yarmouth not till September; but at some part or other of the British coasts herrings may be caught, in larger or smaller quantities, all the year round. Like most other fisheries, the herring fishery is much of a lottery, a single boat sometimes taking more than a small fleet of others in proximity to it. In recent years, single boats from Yarmouth have taken 126, 137, 138, and 142 lasts of fish. A Yarmouth last of herrings is supposed to count 13,200 fish. Sometimes boats catch more than they can carry, and instances are on record of such numbers of fish "striking the nets, that the warp ropes have broken, and the fish and gear have all been lost." An instance of this has recently happened in Scotch waters.

The seine, or sean-net, which comes next for description, is the oldest kind of net in the world, and probably the net often alluded to in the Old Testament Scriptures. The seines used by our fishermen are the seine proper, or ordinary seine, the ground or "foot-seine," and the "tuck-seine." The ordinary seine, as it is worked from a boat, is shot in a circle, and the ground-seine in a semi-circle, from the shore. Some seines are 100 to 300 fathoms in length, and 10 to 15 fathoms in depth, and are used for the capture of pilchards, herrings, mackerel, smelts, grey mullet, and, indeed, any fish which is either more or less a surface swimmer, or hangs to the shore. The difference between the different kinds of seines relates almost entirely to the manner in which they are worked; but they all have the character in common of surrounding or enclosing the fish. The middle, or "bunt," of a seine-net is always deeper than the two ends—"sleeves" or "wings"—which gradually deepen towards the middle, the object being to give the enclosed fish less opportunity of escaping underneath as the net is being hauled in. When the net is being drawn on the shore, the gradual deepening from the ends towards the middle enables the foot, or lower rope, in most cases to touch the shelving bottom at the same time. The back, or upper edge, is supported at the surface by corks, and the foot is weighted by leads, so that the whole wall of netting hangs perpendicularly.

Seines are much used in the mackerel fishery in the west of England; but, like the herring fishery, it is uncertain work. Sometimes immense hauls are made, a single cast of the net occasionally, in the early part of the season, realising as much as £100. Two boats are employed for each net, the one larger than the other. The larger, which contains the nets, takes out four to six men besides the captain, the smaller but two or three. When the captain has decided to begin to cast, the occupants of the smaller boat seize hold of the barrel, which is attached to a rope fastened to one end of the net, and hold it fast. The captain meanwhile pays out the net, and has row round, something in the figure of a horseshoe, so as to enclose the whole or part of the shoal of fish. The large boat is gradually rowed round, and eventually meets the small one, and the ends of the net are drawn together. When the fish are thus surrounded, there is a good deal of splashing and dashing among them, but few seem to have the sense to sink down and escape under the nets.

Seine-fishing is carried on in Cornwall on a much larger scale than elsewhere. St. Ives has long been famous for its pilchard fishing, which is conducted with seines as well as with drift-nets. Between 200 and 300 seines are always kept ready for work. Sometimes two or three nets are used for enclosing a large shoal. The first or principal net is about 200 fathoms long, and 10 fathoms deep in the centre, and another net is fastened to it called a "stop-seine." These nets are shot at the same time, the boats starting from the point where they are joined, and ultimately bringing together the two ends, and thus encircling the fish. The circle is then gradually contracted by hauling up the stop-seine till the whole of the fish are enclosed in the large seine alone. Sometimes, if the number of fish is likely to be very large, a second stop-seine is brought into requisition. When the fish are finally enclosed in the one seine, the net is gradually hauled towards the shore to some quiet spot, where it is moored when the foot touches the bottom. It may then take several days to empty the net, if the haul be a large one. For this process of emptying, another net, called a "tuck-seine" is employed. This is a small net, shot inside the circle of the large one, and its middle is gradually raised from the foot, lifting up the fish, and bringing them to the surface. They are then dipped out in large baskets, and boats convey them to the shore.

The ground or foot-seine, as its name suggests, is that which is used from the shore, and so often seen at work by visitors to our watering places. It has a rope attached to each end of it, one of which is left in charge of some of the fishermen on the shore. The net is cast from the boat, which is rowed round in a semi-circle to the shore again, and then follows the hauling in with with the two ropes, and afterwards by handling the net itself, the parties of haulers gradually approaching each other till they meet. By this time the net is nearly on shore, and the fish collected in the centre. The last operation is to get the foot-rope well under the fish, and haul them bodily out in the net, which assumes finally something of the form of a net hammock. All kinds of fish are caught in these ground-seines, but of course it is only on sloping shores with a smooth bottom that their use is practicable.

A few words may now be said in reference to other kinds of nets used in our fisheries, in addition

to those already described under the names of trawls, drift-nets, and seines. Trammel, or "set-nets," are of two kinds. The ordinary trammel may almost be described as a "fixed" drift-net, being merely a single net, set at the bottom of the sea with "anchors" and "buoys," which cause it to assume the shape of a perpendicular wall of network; but it is mounted very slack on the head and back ropes, so that the netting has a good deal of play. The size of the meshes varies according to the fish fished for. Large quantities of hake are taken in this kind of net in some Irish fishing districts, and cod, herrings, and even turbot, are among the victims to it. But the true trammel is composed of three nets or distinct sets of meshes, and hence its name in French, *tremail*, or *tramail*, *i.e.*, *trois mailles*, or "three meshes." The trammel is a combination of three long nets, placed side by side, and fastened together at the backs, foot, and ends. Each of the outer nets (or "wallings") has a depth of five meshes ten inches square, and is forty or fifty fathoms long. These two wallings are mounted so that the meshes of both exactly correspond in position, and a fish might pass them as if they were a single net. The third net, however, is placed between the other two, and has its meshes only two inches square; but it is both twice as long and deep as the outer ones, the excess being gathered in at short intervals along the ridges where the three nets are united. The result is a large quantity of slack netting between the two outer nets. The apparatus, which is set with its length in the direction of the tide, is anchored and buoyed at each end, the back or upper edge being well corked, and the foot weighted to keep the whole length in a proper position. Thus the trammel is a kind of trap, the fish as they "strike" on either side carrying a portion of the slack net between the larger meshes of the middle net, and so making, as it were, pockets for themselves, and becoming hopelessly "trammelled." It is in this kind of net that the large red mullet, so dear to epicures, are taken round Guernsey; and it is in use in certain parts of Devonshire and Cornish coasts.

The kettle-net is mainly used for catching mackerel when they come near the land in some districts, and particularly along the Kent and Sussex coasts. It is an arrangement of stakes and nets, so constructed as to lead the fish into an enclosure whence, practically, there is no escape. The first portion of the kettle-net construction consists of a circle of stakes from 100 to 200 yards in circumference, ten to twelve feet high, and eight to ten yards apart, with netting stretched all round them from their tops to the ground. This forms the "pound" constructed just below low-water mark at neap tide, with its entrance on the land side about thirty to forty yards wide. The other part of the construction consists of a barrier of stakes and netting, in a straight line from high-water mark to a short distance within the entrance to the pound, and this prevents the fish from passing between the pound and the shore. Kettle-nets are constructed on shores of such a slope that at high-water the pound and the greater part of the barrier are covered by the water. When once the fish have been led to enter the pound, it is seldom that they find their way out again through the comparatively narrow entrance; and as the tide falls, and the greater part of the pound becomes dry, they are hopeless captives in the small portion of the water remaining. Out of this they are dipped in baskets, or taken up by a small seine cast around them, after the manner already described in seine fishery, and they are ignominiously carted away in vehicles. This kettle-net fishing is discouraged by the Board of Trade, as the stakes impede navigation, and prevent the more effectual use of seines where they are fixed; and after all, it is but an idle kind of fishing.

Mention may also be made of what is called the stow-net, which is almost exclusively used for the capture of sprats in certain districts, especially at the mouth of the Thames and in the Lincolnshire Wash. It is in the form of a long, narrow funnel, 50 to 60 yards in length, with a mouth 36 feet high and 20 feet broad. It tapers for a length of 90 feet to a diameter of five or six feet, and so forms a gigantic bag-net. It is divided into several parts, the first being called the "quarters," forming the sides of the mouth, and the next is termed the "enter," and forms the last part of the most funnel-shaped portion of the net. When the net is to be used, two wooden spars, or "balks," are fastened to its mouth, one at the top and the other at the bottom, to keep it open, the lower one being weighted. Four ropes leading from the four corners of the mouth of the net are joined to another rope, the end of which is fastened to the anchor of the fishing vessel, and thus, if the anchor drags, the net maintains its same relative position to the vessel. The depth of the net when fishing is regulated from the vessel by ropes attached to the ends of the upper "balk." The net is generally set at the beginning of the tide, and remains down till it is nearly done. Before hauling it up, the mouth is closed by means of a chain fastened to the middle of the lower balk, and passing through an iron loop in the upper one. By heaving this chain over a small davit at the bow of the vessel, the two balks are brought together, and the closed mouth of the net raised to the surface of the water. The rest of the net is then gradually got on board, and the fish measured out from the "cod," or end, into the hold. It is with a smaller kind of stow-net, worked on the same principle as that just described, that the famous "whitebait" of the Thames are captured. That these delicious little fish are nothing but the "fry" of the herring seems now generally acknowledged; but why this fry is only taken in the Thames in any large quantity is still a great puzzle to ichthyologists.

The chief net used for catching shrimps in the Thames is, to all intents and purposes, a small beam trawl-net, with a second beam below instead of a "ground rope," as in ordinary trawls. The head-quarters of the shrimp fishery of the Thames are at

Leigh, a few miles west of Southend, on the Essex coast, from which hails quite a fleet of small-decked vessels employed in this particular industry. That it is an important one may be judged from the fact that between two and three thousand gallons of the "brown" or true shrimp are sometimes sent to London from Leigh in one day. Thus these humble crustaceans both support a large number of fishermen and their families, and disseminate a large amouut of gastronomic enjoyment among her Majesty's subjects.

In the foreign sections of the Exhibition, the most noticeable nets are those shown by the United States. To one acquainted with the nets used by our own fishermen, the absence of some of our most familiar contrivances is remarkable. There is not, for instance, a single trawl-net in the American section, with the exception of one, used only for scientific purposes, and worked by a steamer specially constructed. This has two iron beams, one above the other, forming the mouth of the net, and "butterfly wings" for catching fish which may be swimming above the bottom, and it is made generally with chief regard to strength. There is but very little trawling done in American waters, partly because of the generally rocky nature of the ground to some considerable distance from the coasts, and partly because there is little demand for flat fish (*Pleuronectes*) in the United States. Moreover, if there were, the demand could not be met, as on the American coasts it appears there is but a very scanty supply of turbot, brill, and soles, which are reckoned among our "prime" fish. The halibut is considered, gastronomically, superior to any of the fish just mentioned, and even that only realises 3d. per pound in New York.

On the other hand, nets that are not in common use here are largely employed by the fishermen of the United States. Of these, not the least important are the Fyke-nets, of which no less than 1,095 are in use in Maine, 865 in Rhode Island, and 255 in Connecticut, their value being about 18,000 dollars. A Fyke-net may be described as a large cylindrical or conical drum-net, distended by hoops at intervals, and with two or three internal funnels to prevent the return of the captured fish. From each side of the open mouth a wide flat wing extends, to direct the fish into the net; and between these a long flat "leader" passes out to sea for forty or fifty feet. These nets are set at right angles to the line of coast, and the fish passing along are intercepted by the leader, and by it and the wings are directed into the mouth of the net, and pass through the funnels into the interior. One boat's crew can attend to a number of these nets, visiting them in succession, and they are found very productive in the winter fisheries for the large markets.

Among the most remarkable nets used by American fishermen are the enormous purse-seine nets employed in the mackerel and menhaden fishery. These are some 200 fathoms in length by 18 to 25 fathoms deep. When the net is got round a shoal of fish, the ends are closed together so as to form a wide cylinder hanging vertically in the water. At the lower margin of the net are a series of rings, through which a rope runs, and this is tightened when the shoal is surrounded, so that the net then forms a "purse." Sometimes as many as 1,000 barrels of menhaden, or 500 of mackerel, are captured at one time. The fish are sometimes so numerous as to form an almost solid mass, and they are baled out by dip-nets. The fishing vessels generally carry two purse-seines, one of the size given above, the other shallower, for use in shoal water. The fish, it is to be remarked, after a time get shy, and are difficult to capture, except on moonlight nights. As it would be impracticable to cure and barrel all the fish caught in one haul, gigantic net pockets, supported on poles fifteen or sixteen feet in length, extending from the sides of the vessel, are rigged up; these will hold from 200 to 300 barrels of fish at a time, and are regarded as a very great improvement on the methods previously adopted, as the fish can be retained alive, and all can be cured on board. The use of these purse-seines has vastly increased the profits of the mackerel fishery. A stock worth $20,000 is no uncommon supply for one schooner, and sometimes the value of $35,000 has been exceeded. The purse-seines have to be made of stout cotton, as otherwise they are apt to be torn or bitten through by the larger dogfish, when the shoal escapes. An admirable model of a purse-seine, with the schooner, boats, and appliances, hangs in the American court, and being suspended on an iron hoop, and made to scale, gives an exact idea of the construction, and mode, and use of the net.

The last net of which we would make special mention is a large trawl net, exhibited in the Spanish section. It is a very well executed and interesting model, and is represented as being drawn along by two one-masted feluccas. It is a huge, beamless, seine-like, long-winged trawl, corked above and leaded below, the wings being almost as long as the rest of the net, which terminates with a long "cod," broader at its end than at its entry. It has been termed *bou* and *bœufs*, probably because the two vessels towing it abreast of each other resemble a couple of oxen yoked together. It is said that of all modes of trawling this is the most destructive, first, because the net has such a sweep; next, because the meshes are so small, and it is weighted with so much rope and lead; because, too, it is towed with such force and swiftness, that it scrapes and overturns the bottom, not only tearing up vegetation by the roots, and letting no fish escape, but even damaging many of those heaped together in the cod; and, finally, because it is used the whole year through, in all depths and seasons, so that where this mode of fishing is pursued, fish is ever found scarce. The *bou* must be many fathoms long, and the leaded ground-rope, extending along the long wings on either side, is brought up to each felucca, and thus it has no actual warp. The whole apparatus is as striking from its simplicity as it is for its vastness and great sweeping power.

Most of the nets in other foreign sections are chiefly to be noticed for their quaintnesss, and as objects of curiosity rather than of utility to British fishermen. It may, however, be worth our while to make experiments with some of the American "engines," and it is satisfactory to learn that arrangements are now being made for bringing to this country some American fishermen, with a vessel and purse-seine nets, for a trial on the East Anglian coast. This is a practical way of turning the Exhibition to account in the matter of nets and their use.

Having briefly run through the subject of nets, it is now necessary to say a few words on fishing with lines and hooks, the method by which the great bulk of cod-fish supplied to our markets is obtained. Sea fishing by means of hooks and lines was probably the earliest method of fish capture, and in vogue long before nets were thought of. Fish-hooks, of a variety of shapes and materials, are to be seen in most museums, dating back from very early periods. Flint fish-hooks have been found in the Mentone bone caves, just as natives of the South Sea Islands yet make them of mother-of-pearl. Fish-hooks of bronze have been found in considerable abundance on the site of several Swiss lake dwellings; and it is not a little remarkable that in form many of them are almost identical with the steel fish-hooks of the present day. The barb is in most instances present, and double hooks are occasionally found. The attachment to the line was, even in single hooks, frequently made by a loop or eye, formed by flattening and turning back the upper part of the shank of the hook. A whole volume might be written on fish-hooks, ancient and modern, but here the practical use of hooks and lines in sea-fishing only can be described.

There are two kinds of line fishing practised by our fishermen, the one with what are termed "hand-lines," *i.e.*, lines held in the hand of the individual fisherman who uses them, and the other with what are termed "long-lines," which are shot out of a vessel or boat, and then hauled in when they have been a certain time in the water. The former are used more or less all round our coasts, and generally within a moderate distance of the shore, and with them most of our whiting are taken in the Channel towards the West, and a variety of other smaller fish; but the latter are employed further from the shore, and principally on the famous fishing-grounds in the North Sea, for the capture of cod; though haddock, ling, halibut, and sometimes turbot, skate, and other ground fish are taken on them. Cod are also taken in large quantities by hand-lines from about ten to twenty miles from our Eastern coasts, as during the summer months they come closer to shore in pursuit of their favourite food, the herring. The hand-line used in this kind of fishing has a leaden "sinker" of about 6 lbs. weight at the end of it. A short iron wire, called the "sprawl-wire" is fixed to the top of the lead at right angles, and to each end of it is fastened a "snood" of thinner line with a hook attached. The vessel is hove-to when the fishing is going on, and each member of the crew works a line, regulating its distance from the ground as he judges best. A peculiar method of hand-lining, known as the "dandy-line-fishing," is sometimes resorted to with great effect, and it has been compared to what is known among fresh-water anglers as "paternostering." The line has a sinker at the end of it, and at intervals pieces of whalebone or short wires, from six to a dozen in number, are fixed at right angles to it, and to these bright hooks are attached. The peculiarity of this method of fishing is that the hooks are not baited, their glittering appearance as the line is gently lowered and raised being a sufficient attraction to small herrings, which are the fish mainly caught on dandy-lines.

The long line is known by a variety of names, according to the locality in which it is used, and its size—for instance, "spiller," "spilliard," "bolter," and "trot." Grimsby may now be said to be the head-quarters of this kind of fishing. A "set" of long-lines, as used on board a large smack, consists of about fifteen dozen or 180 lines, each forty fathoms long, with twenty-six hooks or "snoods," at intervals of a fathom and a-half all along the main line. A "string" of this description carries more than 4,500 hooks, and when laid stretches about eight miles. The line is always laid across the tide, and is paid out as the smack progresses under easy sail, small "anchors" being attached to it at every forty fathoms, to keep it steady. Its position at each end, and at every mile along its course, is marked by a conical hooped buoy ("dan") which has a pole passing through it, with a small flag at the top. After remaining down till the tide has nearly finished, the hauling up commences, the smack salling as near as she can along the course of the line indicated by the "dans," but making short tacks if necessary. Sometimes, if the wind is very light, the line is taken up by the smack's big boat. As the line comes on board, and the fish are taken off, it is carefully coiled on a series of trays or flat baskets, ready for the hooks to be re-baited. The baiting of the hooks has to be carefully done, and each has to be kept clear of the line, so that no entanglement may take place as the line is being paid out.

As cod taken by line-fishing command a high price in the market, it is a great object to keep them alive as long as possible. For this purpose the smacks used in this kind of fishing are constructed with wells, which form an actual part of the vessel, holes perforated in her sides allowing the water to pass right through her. These "welled-smacks" are said to have been first built in this country at Harwich, in the year 1712, though the idea was probably of Dutch origin. In 1735, thirty of these smacks hailed from Harwich, and in 1798, the number had increased to nearly 100. It seems that from that date the fishing industry began to decline at that port, as welled smacks began to be built at Barking and other places

along the Thames. Within the last thirty years, these Thames welled-smacks brought their cod and haddocks up the river "all alive" in their wells, to within a few miles of Billingsgate, to which they were then taken by small sailing craft, known as "hatch-boats." But as the river became polluted by the increase of sewage, the practice was gradually discontinued; and it is hardly necessary to say that no fish could now live even for a few hours in the filthy water of the Thames. As it is, even out at sea a large number of the cod die in the wells, from which they are immediately taken, and kept in ice till the vessel comes home to discharge her catch. Ten days' line-fishing on the Dogger-bank will sometimes yield twenty or more score of live cod, and two-thirds of that number are kept in ice.

At Grimsby, in the docks, the live cod, when taken out of the wells of the smacks, are put into wooden boxes or chests, of seven feet long, four wide, and two deep, each of which holds from 40 to 100 fish, according to size. The fish will live in them a fortnight or more in the Grimsby fish dock. They are taken out and killed by a blow on the head as they are wanted for the London and other markets, to which they are conveyed by rail. They are known in "the trade" by the name of "live cod." The crimping operation is performed after the fish has received its death-blow, but before muscular contraction has ceased, and it may be effectually performed some hours after death. There are sometimes as many as 400 chests of live cod in the Grimsby fish dock, containing from ten to twenty thousand fish. At Harwich also, cod are stored in a similar manner, the fish being brought there by smacks hailing from various ports.

The baits used in long-line fishing are chiefly whelks, but mussels, and pieces of herring, whiting, and lampreys are also employed, and even bullock's liver when other bait is scarce. British fishermen, with the national spirit of adventure and enterprise, stand quite at the head of this sort of fishing, both in the number and size of the vessels employed, and as to the wide area of the North Sea and other waters in which they push their quest. So far from showing any signs of failing, the "live" cod trade in our hands has steadily increased, and having of late years become centered at Great Grimsby, as the long-line fishing port, has increased the population of that busy place, since 1855, from 10,000 to 40,000; and the cod smack tonnage at the same time from 800 tons to over 40,000 tons. Speaking of the practically inexhaustible supply of certain kinds of fish, in his inaugural address prefatory of the Conferences at the Fisheries Exhibition, Prof. Huxley alluded to the "coming in," as it is called, of the cod on the coast of Norway, in the months of January and February, which is one of the most wonderful sights of its kind in the world. The fish then form what is called a "cod's mountain," of from 120 feet to 180 feet deep, and the fishermen, when they let down their loaded lines, feel the lead knocking against the bodies of the fish for a long time before it gets to the bottom. The Professor said that, allowing each fish to be four feet long, and to be a yard apart, there would be in a square mile of such a shoal something like 120,000,000 fish; a calculation which he said he believed was considerably under the mark. He went on to say that, as herrings were the main food of cod, if they allowed each cod in a square mile but only one herring a day, they would consume, in the course of a week, 840,000,000 herrings. He believed that the whole Norwegian herrring fishery had never yet reached half that total of fish; and, further, that all the fishing operations of all the nations of the earth did not result in catching 5 per cent. of the fish which were the subject of the great sea fisheries, namely, cod, herrings, mackerel, pilchards, and the like.

A considerable share in the long-line fishery for cod is taken by our French, Belgian, Dutch, Swedish, and Norwegian neighbours. From some of these, useful hints may be gathered. Thus, the Swedes put a cedar-wood float on each of the snoods, to keep the bait afloat when the long line is on the bottom, and so preserve it from the attacks of star-fish and "creeping things innumerable," which populate the bed of the sea; while those grand sailors and fishermen, the Norwegians, finding that cod frequent the water at different depths, and that the bottom is not always the best place for them, buoy their long lines by means of glass globes (of which samples are shown in the Norwegian and other sections of the Exhibition), at such depths as they have found by trial to be populated with fish, and very often take many hundreds of fish on one of their lines; while their less scientific rivals, who have stuck to the bottom, have drawn a blank.

PANDANUS, OR SCREW-PINE BREAD.

The *Pandanaceæ*, or screw pines, are a most interesting group of endogenous plants, somewhat palm-like in their habit. They are either shrubs or trees, with numerous adventitious roots, which often, indeed, wholly support the tree after the main or true root has rotted away. They have long, imbricated, amplexicaul leaves, the margins and backs of which are usually spiny. The fruits are either fibrous drupes, collected in parcels, or berries; in the drupes the seeds are solitary, in the berries numerous.

The best known examples of this order are *Carludovica*, *Pandanus*, and *Nipa*; although, by some authors, *Carludovica* and *Nipa* are taken as typical genera of natural orders. (See Dr. Hooker's edition of Le Maout and Decaisne's Botany.)

The genus *Carludovica* is confined to South America, and the so-called Panama hats are made from the leaves of the *C. palmata*.

The *Nipa fruticans* is a common object in the salt marshes of the islands and coasts in the Indian Ocean, and is a low stemless plant, palm-like in habit. The

leaves are most extensively used as a roof thatch, for which, indeed, they are admirably adapted. When burnt, the leaves yield salt, the spathe yields toddy, syrup, sugar, vinegar, yeast, or spirit, at the will of the operator. The seeds are edible, being somewhat like coconut in taste, the slight insipidity in taste being corrected by sugar.

The true *Pandanæ* are, however, the more interesting. Of the genus *Pandanus*, there are several species, confined to the Eastern hemisphere, being very numerous in the Indian Archipelago, found principally in the vicinity of the sea, and forming one of the "aspects of vegetation." To clear one's way through these almost impenetrable masses, requires a strong arm, a good belt-axe, and, above all, a good temper. Some of the *Pandani* run from 10 to 15 feet in height. The leaves are long, narrow, tough, and leathery, with the edges and midrib armed with sharp recurved spines, which have a most provoking way of intruding in one's clothes or flesh, putting one in mind of the "wait-a-bit" thorn of African travellers. The fruit consists of a number of wedge-shaped drupes, clustered often into large coal-like heads. The aerial roots too, with their cup-like spongioles, are very remarkable.

The leaves of the *Pandanus utilis* of Mauritius are made into sugar bags, and often are utilised in this country as fish baskets. The fruits of *P. fœtidus* are extremely fœtid, whilst those of *P. odoratissimus*, are, as the name would imply, the reverse. It is, however, in the Nicobar Islands where the *Pandanus* is fully appreciated, and holds a position almost equalling that of the coconut in Ceylon as a source of food.

In the Nicobars, the *Pandanus* grows to about thirty feet in height, and luxuriates on the banks of creeks and marshy ground, and almost equally as well on undulating grassy plains in the interior. The cone, or head of drupes, attains a length of fourteen to fifteen inches, and a breadth of nine to ten inches, being first of a dark green colour, changing to a dull red on ripening. The ripe fruit is gathered by the natives, the finer sorts being selected for breadmaking, the inferior being given to the pigs. The drupes are then separated from each other, and placed in a large earthern vessel, which, when about two-thirds full of nuts, is set on to boil for twelve to fourteen hours, the nuts being kept covered with water during the time. After boiling, the soft dough-like substance which the drupe contains has next to be removed, and is effected in the following manner by women:—They take a shell, and drawing the fruit with some amount of pressure over the edge, force out the amylaceous matter into the shell, which, in the meantime, is held firmly between their toes. The conical-like fibrous brush left is discarded, and fresh fruits treated in the same manner, till a sufficiency of "dough" has been expressed, which is of a pale brownish colour, and largely mixed with portions of the fibrous husk of the fruit. These fibres have next to be removed. To do this, the woman, selecting a long piece of fibre, seats herself on the ground, and fastens one end of the fibre round her right toe, and the other end round one of the fingers of the left hand. Taking the ball of dough in her right hand, she passes the long fibre through and through it, and dexterously removes all the fragments of fibre, without wasting a particle of the dough.

This dough is either eaten in its present state with fish, or pork, or is made into rough cakes and baked on hot ashes. It forms a very nutritious food, but its peculiar sweetish taste cloys on the appetites of Europeans, though, as a substitute for bread or biscuits, or in the form of a pudding, with the addition of sugar or jam, it is by no means to be despised, and to the Nicobarese, who are not an agricultural race, the fruit of the *Pandanus* is a most valuable staple article of food.

FORESTRY.

On all sides complaints are heard of the serious consequences of the destruction of the forests of the world, and reports arrive of the attempts that are being made to improve the present condition of forestry. Delegates from various parts of the United States were present at a Forestry Congress lately held in the Capitol building at St. Pauls, Minnesota. The President, in his opening address, stated that in Ohio, Maine, New York, and other States, the acreage of forests was constantly increasing. In some States an "arbor" day had been instituted, and in these the increase was notable. The forest acreage of the United States, however, was less than one-fourth of the total surface, a smaller proportion than in the east, west, and north of Europe. At the present rate of consumption the supply of pinewood in the Northern States would be exhausted in a few years. Forestry is taught in the State Agricultural College at Lunsing, in Michigan State, which is said to contain a good labelled arboretum and a large collection of native and exotic trees under cultivation. The last Legislature of New York State passed a law to encourage tree planting, by which any inhabitant who shall transplant by the side of the public highway adjoining his premises any forest shade trees, fruit trees, ornamental trees, or any nut-bearing trees, shall be allowed, in abatement of his highway tax, one dollar for every four trees set out. Elms must be placed not less than seventy feet apart, on the same side of such highway, and no maples or other forest trees, ornamental, or fruit trees, nearer than forty feet apart on the same side of such highway.

In Mexico, the Government has contracted with Mr. Oscar A. Droege to plant 2,000,000 trees in the Valley of Mexico, within four years from March 15, 1884, or 500,000 trees a year, in such places as the Government shall choose. The contractor pledges himself to establish a number of nurseries, and to have in them each year at least 800,000 ash, 35,000 willows, 120,000 poplars, 60,000 eucalyptus, 60,000 mountain cypress cedars, 60,000 acacias, and 180,000

other trees. The trees are to be in plantations of om 50,000 to 100,000 each, and Mr. Droege must aintain them for two years after the planting. hree graduates of the School of Agriculture are to e received into the nurseries each year, there to udy the science of forestry. Mr. Droege is to raise uit and other useful trees for distribution, and he is receive annually $40,000 (£8,500), till the sum eaches a total of $200,000 (£42,500). A work on rboriculture, of recognised merit, is to be translated om the German every year in order to disseminate ound views on the subject among the students and ne public.

In Europe the Forestry Schools are now very umerous, and the following list of those in Austria nd Germany has lately been compiled:—Austria eads the list with nine schools—viz., the Imperial ligh School of Agriculture and Forestry at Vienna, ith six professors and 329 students; the Eulenberg chool, with six professors and fifty students, the ourse lasting two years; the Weisswasser School, ith five professors and eighty students; the Lemberg chool, with twelve professors and forty students; ne Aggsbach School, near Melk, with two professors nd twenty-four students; the course of forestry in he technical high school of Gratz; the Styria Forest ulture School, with three professors and twenty-six tudents; the Carinthia School; the Vorarlberg chool. Prussia has three institutions, commence- ng with the Royal Forest Academy at Neustadt-Eberswalde, with a director, fourteen professors, and ther assistants. The course is two and a-half years, nd the number of students about fifty-seven. The Münden Royal Forest Academy has a director, ten rofessors, and seventy-eight students. The Forestry chool at Grosse-Schönebeck and the forestry courses o the Army Forestry Battalion are for the training f lower forestry officials. At the former school are our professors, at the latter eleven, all of them ractical foresters. Saxony has a forestry academy t Tharand, with ten professors and assistants. In Wurtemburg instruction is given at the Royal Agricultural Academy at Hohenheim and at the University of Tübingen. In Baden the forestry department of the Carlsruhe Polytechnic has orty students. Bavaria has a forest academy at Aschaffenberg, with a director and seven pro- essors, in addition to which are six chairs of orestry in the University of Munich; Hesse-Darmstadt has a forestry institution attached to the University of Giessen; and Saxe-Weimar has pos- essed one since 1808, with a director and four pro- essors. No other countries can equal this extensive ist, but France has her famous school of forestry at Nancy, and one of forest guards at Barres, in addition o several agricultural schools and agronomic indus- rial schools, in which forestry is taught. Russia as four schools—viz., the Agricultural and Forestral Academy at Petrovsk, near Moscow; the Agronomic Institute at St. Petersburg, with courses in sylvi- culture; the Forest School at Lissino; and the Forest Division of the Agricultural Institute at New Alexandra. There is an Italian school of forestry at Vallombrosa; a Danish school, attached to the Royal Veterinary and Agricultural College at Copenhagen; and a Swedish forest institute at Stockholm, besides thirteen private elementary schools. In Switzerland the department of forestry forms the fifth division of the Federal Polytechnic School at Zurich, to which are thirty students.

A Spanish school of forest engineering exists at San Lorenzo del Escurial, near Madrid. The British Consul at Malaga reports that the cultivation of the eucalyptus has of late attracted considerable attention in that province, which has been deprived of all but fruit trees in order to supply the constant demand for charcoal, caused by the extensive use of this fuel for cooking purposes. Large numbers of the eucalyptus, in a healthy and flourishing state, may now be seen along the line of railway from Malaga to Bobadilla, and in other places, and they are reported to have been effective to some extent in destroying fevers in the low districts, formerly uninhabitable. These trees are also successfully used to form avenues, and afford protection from the sun on the roads near the city.

Alone, among the great countries of Europe, Great Britain is without any adequate means for the teaching of forestry, and in order to remedy this state of things the Council of the Society of Arts memorialised the Secretary of State for India. (See *Journal*, vol. xxx., p. 879.) It was suggested that by the addition of special means of teaching forest cultivation and cognate subjects at certain of the large educational establishments of the country, such as that at Cooper's-hill, the existing system of sending forest students to Continental schools might be superseded. Last month Sir John Lubbock also drew the attention of the Government to the subject of forest education in Committee of Supply. (See *Journal ante*, p. 877.)

FISH ANALYSES.

The only published analyses of fish which we have in this country, calculated in such form that they can be compared with one another and with other foods, are given in the volume, "Food: Some Account of its Sources, Constituents, and Uses," by Prof. A. H. Church. It forms one of the series of South Kensington Museum science handbooks, and is intended as a "guide book to the food collection" of the Science and Art Department, which, some seven years ago, was removed from South Kensington to the Bethnal-green Branch Museum. The old analyses given in the Bridgwater treatise, and those of J. Pereira, one of the first Englishmen to pay attention to the chemical constituents of foods, are now of no practical use, as the compounds are expressed in combinations, which are no longer used in calculations respecting food values. The analyses given in the

"Food" handbook, the last edition of which is 1876, are only for salmon, mackerel, sole, conger eel, pike, and herring, and these it is stated are quoted "under all necessary reserve" from a former edition. Prof. Church did, in 1876, incorporate one original analysis, that of the herring, and it differs considerably from that quoted from the former edition. The difference is as great as this, the calculations being made for a pound of flesh :—Nitrogenous matter (old analyses), 3 oz. 317 gr.; (new), 2 oz. 70 gr.; oil or fat (old), 1 oz. 56 gr.; (new), 2 oz. In the more recently published "Nahurugs-und Genuss-mittal," by Prof. Koenig, there are several analyses given, but, with the exception of an old analysis by Frank Buckland, they are all from Continental laboratories, and therefore presumably made from examination of Continental specimens of fish, and as fish vary so much in different localities, it is by no means certain that they may be safely taken as representing fish that comes to the British market.

The great difficulty that lies in the way of making use of practical calculations of any of the published analyses is that no statements are given as to the time of year at which the analyses were made, nor of the condition of the fish. It is well known that fish vary much in their composition, especially in the amount of fat they contain, at different times of the year. There is also a difference of fish even of the same species caught off different parts of our coast, as for example, a Dover sole is "instinctively" recognised as different from a Torbay sole, though we are without analysis to tell us what the difference is as regards chemical composition. Every one must have remarked the great difference there is in the richness of herrings, both in regard to season and the place they come from. There is this further drawback to relying on published fish analyses for practical purposes, that it is not stated whether they are the average of many analyses or are single experiments.

As a matter of fact, fish analyses have not been wanted for any practical purposes till now. The public dietaries for our soldiers and sailors, our pensioners, our reformatory boys, our paupers, and our criminals, have never included fish even in localities where fish is plentiful. There have been many returns at different dates to the House of Commons on workhouse dietaries, but they may be searched in vain for any mention of fish. As regards soldiers' diet, it is true that several hundred portions of fried fish, principally plaice and haddock, are sent daily to the barracks of our Guards in London at tea time, and the men are allowed to purchase of the privileged dealer what they care to pay for, but it does not form any part of their regulation diet. This year an attempt has been made to introduce fish into workhouse dietaries, but the first attempt at Canterbury was a signal failure, the inmates asking that they might be allowed to have their former diet. In one or two other workhouses since then, where double the quantity of fish has been substituted for meat, it has been received with less disfavour. Unfortunately, the only information given in any of these cases is the vague statement "Fish was substituted for meat." With regard t "meat," most of the returns very clearly stated no only which are "beef days" and which are "mutto days," but what are the joints used. It is wel known, chiefly from the many years' experiments a Rothampstead, not only what is the nutriment valu of cattle and sheep of different breeds and in differen conditions, but the value of different parts of th animals are known. The vague term "fish" con veys no information as to nutriment value at all Allowing for all imperfections in the exactness an fulness of our knowledge of fish, the English an the Continental analyses show unmistakeably tha some *genera* have far higher food values than others For example, the nitrogenous, or flesh-forming com pounds, differ as follows (according to the handbook), the calculations being per pound of flesh :—Mackerel, 3 oz. 387 gr.; conger eel, 3 oz. 233 gr.; pike, 3 oz. 23 gr.; salmon, 2 oz. 48 gr.; sole, 1 oz. 350 gr.; herring, 1 oz. 270 gr. Thus the flesh-forming compounds in mackerel may be reckoned at double the quantity present in herring, even if the newer analysis of 2 oz. 70 gr. be taken. The amount of fats, or heat and force producers, is quite a secondary consideration, because they can be had from flour and rice and many vegetables, and the fat with which fish are cooked, but none of which contain more than very small quantities of flesh formers. It is hardly to be expected that salmon and soles should be introduced into public dietaries, but mackerel and herrings are often cheap enough. The importance of knowing the composition of the flesh of fish is at least illustrated by the comparison of these two. If the rations are served by weight, then there would be double the amount of flesh-forming material served out when mackerel is used than when herring is used; if they are served on a chemical basis—in many dietaries they are—then twice the weight of herring must be served to what must be given when mackerel is used. For comparison, the flesh-forming compounds in beef may be taken at about 3 oz., that is of the parts that can be eaten and digested, and mutton rather less.

The question of cost of course largely enters into calculations in public dietaries; even supposing the flesh-forming constituents of fish are given at the highest amount when in best condition, it is evident they are not less than that of meat, while the cost is far less. Of the cheaper fish, such as plaice, haddock, whiting, there do not seem to be any analyses at all, and, therefore, the introduction of these into dietaries would be an uncertain step at present.

AGRICULTURE IN VENEZUELA.

Consul Beach says that few countries are more highly favoured than Venezuela in having a large area of good soil and climate conducive to the growth of vegetation. Topographically, it embraces moun-

ains, valleys, and plains, and nearly all of its soil bears a luxuriant growth of natural and spontaneous vegetation, and is capable of sustaining prolific cultivated crops. Meteorologically, the year may be divided into two seasons of six months each; the summer season, beginning with May and ending with October; and the winter season embracing the other six months. The climate is very uniform the year through; during the summer season the temperature ranges between 75° and 85° Fahr., with no severe gales or storms, and in the winter between 70° and 80°. Of the several kinds of crops grown, coffee is the only one that has its season, blooming in May, and maturing in August and September, yielding but one crop a year. The landscape views, whether embracing mountains, valleys, or plains, are alike at all periods of the year, always bright in verdure, and the natural flowers blossom the same in January as in April, July, or October. For the same reason the fruit and vegetable supply is very uniform, cucumber, cabbages, new peas, beans, tomatoes, oranges, pine-apples, bananas, melons, &c., being always abundant. The orange trees contain, at the same time, blossoms and fruit in all stages of growth, from the first setting to that fully matured. The lemons, limes, coconuts, and other fruit-bearing trees, possess the same characteristics. There is a class of products requiring but little cultivation of the soil, in this is included coffee, cacao, oranges, lemons, limes, and coconuts. The land is cleared, then the trees are set out, after which the wild vines and weeds that spring up are kept down by the frequent cuttings with long bladed knives. No other cultivation appears to be required. Coffee is the most valuable crop produced in Venezuela, and nearly all of the financial interests of the people are largely contingent on it, the amount of the crop, and its export value. Cacao is also an article of considerable importance, and is exported in considerable quantities. White grapes of the finest quantities are produced, and Consul Beach says, "no good reason appears why the extensive arable mountain ranges might not be utilised for their production, as the maritime Alps in France and Italy are utilised." The methods of cultivating the land are very crude and antiquated. Modern ploughs are never to be seen, and the only description of plough which appears to be used is made by pointing a round stick about six inches in diameter, and encasing the point in iron. This iron-pointed stick, set in a frame at a suitable angle, and drawn by a team, turns a furrow each way. Much of the tilled land is not cultivated by ploughing, but by hoeing. After it has been cleared by cutting the jungle and burning it, a crop is planted by hoeing, and the hoeing is continued at intervals until the crop is harvested. Of the cultivated crops, corn or maize is the most important; near the cities it is grown expressly for feeding horses, and is the principal food of all the ox teams, horses, mules, and donkeys used for the transportation of merchandise in the interior. When grown for stock feeding, the grower plants the seed so as to have a constant supply at full growth, which is put into the market green, in bundles. In places remote from the large towns, the corn fully matures, and is sold in the grain by the hundred pounds weight. Three crops of corn can be reproduced yearly on the same land. Sugar-cane is grown by a process of cultivation similar to that of corn, and sugar is produced in sufficient quantities to supply the home demand. It is sold both in a raw state, and imperfectly refined, but the greater part sold is raw. There is produced from the sugar-cane a species of rum, which is largely used by the native population. Nine or ten varieties of beans are grown, and usually in great perfection, but only in quantities sufficient for domestic use; peas are also a prolific crop, but are grown only in quantity to supply home consumption. Considerable attention is paid to the rearing of live stock in Venezuela; the cattle are large, and the working oxen are especially strong and serviceable. The horses are of medium size and inferior appearance, but the breed of mules is considered excellent. Goats are to be found in great numbers; in some of the mountain districts they are kept in large flocks, often containing more than a thousand; they are rendered profitable through the sale of their skins and flesh, the latter in the form of jerked meat after being dried.

General Notes.

International Congress at Amsterdam.—In connection with the Colonial and Export Exhibition, an International Congress on subjects connected with commerce and industry, colonial possessions, and the arts and sciences, opened at Amsterdam on 11th September. The questions for discussion are as follows:—1. Legislative or Government measures for the protection of commerce and industry. 2. International law as to bankruptcy. 3. International currency. 4. Examination of the Berne convention of 1881, as to the carriage of goods by railway. 5. International measures for preventing collisions and other accidents at sea, and for rendering their consequences less disastrous. 6. Uniform legislation as to bonds issued by States, Provinces, Towns and Companies. 7. Patents for inventions, protection of trade marks, and industrial designs. 8. International uniformity of practice in the chartering of vessels. 9. International legislation on bills of exchange. The Secretary-General is M. D. Josephus Jitta, Exhibition-offices, Amsterdam.

Production of Gold and Silver in Mexico.—The French *Revue de la Finance* says that since the conquest of the country by Europeans, there has

been no cessation of work in the gold and silver mines of Mexico. While it was under Spanish rule, that is from 1537 to 1821, the value of silver produced exceeded 10,431,348,515 francs, and of gold 343,842,055 francs, but since its independence, dating from 1821 to 1880, the value of silver extracted amounted to 4,503,291,545 francs, and of gold 247,068,930 francs, making the total value of the gold and silver produced in Mexico, during the period comprised between the years 1537 and 1880, amount to 15,525,551,045 francs, the average annual production being about 45,300,000 francs. It appears that the State of Chihuahua is the most prolific of the whole of Mexico, in precious metals. This State is divided into twenty cantons, in which there are 120 mining districts, and in these districts there are 575 mines, which have been regularly worked since the Spanish Conquest. It has been found necessary to suspend work in mines which yield more than three and a-half kilogrammes of silver to the ton of ore, on account of the difficulty experienced in transport and the want of proper machinery. According to the *Revue de la Finance*, it only requires an improved method of extracting and treating the ore to raise Mexico to the first rank in precious metal producing countries, a position which she held previous to the year 1848. It is expected that the completion of the central railway, traversing the State of Chihuahua, which is now in course of construction, will materially contribute to this result.

Ensilage.—Mr. T. H. Miller, of Singleton-park near Preston, has lately made an experiment to see whether it is necessary for a "silo" to be a pit or excavation. He made use of an old cart-house, above which was a granary, the flooring of which he had cut away, with the exception of a portion at one end to serve as a platform. The walls of the building were lined with cement to the height of eight feet, and when this was set the filling of the silo began. Between the 25th of June and the end of August there were placed in it, at irregular intervals, 15 tons of meadow grass in a wet condition, 15 tons 4 cwt. of rye grass and clover, and 4 tons 15 cwt. of green oats in full head, chopped into 3 in. lengths; total, 34 tons 19 cwts., the produce of seven acres. The mass was kept covered with slotted boards, and weighted with 200 bags containing 126 lbs. of sand each. These were manipulated easily by means of a rope and pulley, worked from the platform. On the 27th ult. there was no heat or brewing, and but the very slightest perceptible warmth. A portion of the ensilage, taken from the depth of thirty-seven inches, was of a yellowish brown, and moist, but perfectly sweet. A bullock ate some of it greedily, and a handful put in some hay was eaten by a cow before she would touch the hay. The silo is to be formally opened in November, in the presence of a number of farmers and friends.

Canned Fruit Trade in San Francisco.—In a report from San Francisco, quoted in the *Gardener's Chronicle*, under the head of "Canned Fruits and Vegetables," it is stated that this industry has vastly increased during the past few years, and promises still larger development. In the city of San Francisco and Oakland there are eight large canning establishments, and in other parts of the State there are a few large and many small ones. About a year ago the city canners entered into a combination for the protection of their several interests, forming an incorporated company. The selected one of their number as the sole purchaser of all the fruit and vegetables required by their canneries, and this was strictly adhered to all through the year, and worked satisfactorily. It is estimated that these canneries pack over three-fourths of all that is packed in the State, and that more than half the fruit grown in the State is packed by them in the canneries in San Francisco and Oakland belonging to them. The following is given as the result of the year's packing, all the quantities being in pounds:—Apricots, 3,087,740; asparagus, 115,050; beans 89,109; white cherries, 543,458; dark cherries, 288,689 currants, 475,321; gooseberries, 102,418; grapes (Muscat), 923,588; grapes (Isabellas), 24,337 peaches, 2,763,781; Bartlett pears, 2,216,484; peas 1,006,524; damsons, 187,816; egg plums, 294,892 golden drop plums, 141,014; blue plums, 153,509 prunes, 151,390; gages, 518,088; raspberries 60,132; strawberries, 11,943; tomatos, 5,844,031; quinces, 246,613; blackberries, 412,798; apples 1,448,210.

THE LIBRARY.

The following books have been presented to the Library:—

Gibb, E. J. W.—Ottoman Poems translated into English verse (London: Trübner and Co., 1882.) Presented by the Author.

Lichtenfeld, Joseph.—Principles of Physiognomical Hairdressing. (Published by the Author.) Presented by the Author.

Macfie, R.A.—Copyright and Patents for Inventions, Vol. II. (Edinburgh: T. and T. Clark. 1883.) Presented by the Author.

Newbigging, Thomas.—The Gas Manager's Handbook, for Gas Engineers, Managers, and others engaged in the manufacture and distribution of coal (London: Walter King, 1883.) Presented by the Author.

Stephens, Frederic George.—Catalogue of Prints and Drawings, in the British Museum. Division I. Political and Personal Satires. Vol. IV. (Printed by order of the Trustees.) Presented by the Trustees.

Willshire, William Hughes, M.D.—Catalogue of Early Prints in the British Museum. German and Flemish Schools. Vol. II. (London: Longman and Co., 1883.) Presented by the Trustees.

Journal of the Society of Arts.

No. 1,610. Vol. XXXII.

FRIDAY, SEPTEMBER 28, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PREMIUMS FOR THE 129th SESSION.

The following Prizes are offered by the Council for the year 1883:—

John Stock Prize.—A Society's Gold Medal, or £20, for the best design from a poem, or from history, or from the Scriptures, prepared with a view to Mural Decoration.

Benjamin Shaw Prize.—1. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the operations of coal-mining." 2. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the manufacture, storage, and transport of explosives."

The Council leave it to the competitors to bring the plans under their notice in any way they may think proper, whether by model, written description, or otherwise.

Howard Prize.—A prize of £100 for the best Essay on the Utilisation of Electricity for Motive Power. Preference will be given to that Essay which, besides setting forth the theory of the subject, contains records with detailed results of actual working or experiment. The Society reserves the right of publishing the Prize Essay.

Fothergill Prize.—A Society's Gold Medal, or £20, is now offered for the best Invention having for its object the Prevention or Extinction of Fires in Theatres, or other places of public amusement.

Mulready Prize.—A Society's Gold Medal, "to that student in a School of Art in the United Kingdom, who exhibits the best Drawing from the nude figure, executed in black and red chalk, in the manner so successfully practised by Mulready."

Designs, plans, models, essays, descriptions, inventions, &c., intended to compete for any of the above Prizes, must be sent in on or before the 31st October, 1883, to the Secretary of the Society of Arts, John-street, Adelphi, London.

Further particulars relating to the Prizes may be obtained on application to the Secretary.

Miscellaneous.

*THE EUPHRATES VALLEY RAILWAY AS AN ALTERNATIVE ROUTE TO INDIA.**

By J. B. Fell.

Fifty years ago a project was formed for the construction of a railway along the route of the Euphrates Valley, which was reconnoitred by General Chesney, who made a most enterprising and interesting voyage of 700 miles down the River Euphrates. A sum of £2,000 was afterwards voted by Parliament for a regular survey for the proposed Euphrates Valley Railway, which was made, under the instructions of Sir W. P. Andrew, by General Chesney, Sir John Macneil, and others, who also prepared estimates of the cost.

Since that period the subject has frequently been brought before the notice of the Government, and of the public, and a large and influential committee or association was formed for promoting the construction of the Euphrates Valley Railway, of which the Duke of Sutherland is the president, and Sir William P. Andrew, Chairman of the Scinde Railway, is the chairman.

No actual progress has, however, yet been made with the enterprise, either in the way of obtaining the concession from the Turkish Government, or in providing the necessary capital; but recent and most significant events seem to indicate that the time when this railway must and will be made is near at hand.

The construction of the Euphrates Valley Railway is every year becoming more urgent and imperative, both from commercial and political considerations. Our trade with India and the East has grown so enormously during the last five years that the Suez Canal is no longer able to carry it, the traffic of the Canal having increased from about three millions to six millions of tons per annum in the five years from 1877 to 1882; and our trade with India has increased from £17,00,000 to £70,000,000 sterling since the date of General Chesney's first expedition down the Euphrates.

* Abstract of paper read before Section G of the British Association, at Southport.

For the maintenance and further development of this vast trade, increased facilities for the transport of passengers and goods are required, such as can only be afforded by railway communication, and that, not by the Egyptian, but by the Euphrates Valley route. Even if the Suez Canal had been sufficient commercially to carry the Eastern traffic, it would still have been quite insufficient from a stategical point of view, because, as recent events have shown, circumstances might arise by which the Suez Canal route would be destroyed, or blocked, for months or years.

It is proposed to consider in this paper:—

1. What advantages the Euphrates Valley Railway would have for the carriage of passengers, the mails, troops, and light merchandise over the Egyptian Railway, and Suez Canal routes.

2. To what extent the Euphrates Valley Railway could compete with the Suez route for the transport of heavy merchandise.

3. Whether, in the possible event of the Suez Canal being closed, the whole of the traffic passing through the Canal could be carried by the Euphrates Valley Railway.

Two ports as points of departure on the Mediterranean were examined by General Chesney and Sir John Macneil, one being Seleucia, the Port of Antioch, and the other Alexandretta, in the Bay of Scanderoom, the latter being considered to be the best, as the least expensive to construct, and from its being in a fine natural harbour, deep enough and large enough to accommodate the whole of the British Fleet. From Alexandretta the railway would be carried over the Bailan Pass, the summit of which has an elevation of 2,000 feet, whence the line falls down to Aleppo at a distance of ninety miles. From Aleppo the railway runs with easy gradients, and over favourable ground, to Bussorah or El Kewit, at either of which places on the Persian Gulf excellent landing accommodation could be provided for the largest ships afloat.

The length of the line from Alexandretta *viâ* Bagdad to Bussorah would be 850 miles, the average gradient 1 in 500, and there would be but few curves beyond Aleppo less than forty chains radius. The estimated cost for a full gauge single line with passing places is £10,000 per mile, or £8,500,000.

	Per annum.
Sir William Andrew estimates the through traffic at	£406,521
The local traffic at	540,681
	£947,202
Less working expenses 50 per cent.	£473,611
Nett revenue.....	£473,601

The estimated nett revenue of £473,601 is sufficient to pay 5½ per cent. on the estimated cost of the railway.

Taking into account the immense traffic to India and the East, now passing by way of Egypt, the above appears to be an under-estimate of the probable traffic of the Euphrates Valley Railway; and, considering the rates of carriage proposed, the working expenses appear to have been taken at too high a percentage, consequently the rate of carriage might probably be reduced to such an extent that, for certain large classes of goods, the rates for carriage would but little, if at all, exceed those paid by the Suez Canal route.

The Euphrates Valley Railway would, therefore, be able to compete on advantageous terms with the Suez Canal; and it might not be an extravagant estimate to assume that it would carry one million tons of goods, or even more, per annum out of the 4½ millions of tons of British goods now passing through the Canal.

The advantage of the Euphrates Valley route over that by Egypt, for the transit of passengers, troops, and the mails, would be immense and indisputable, as there would be a clear saving of five days in the journey between London and Bombay.

The maximum carrying capacity of the Euphrates Valley Railway may be estimated at three millions of tons of goods for a single line, and ten millions of tons for a double line of railway, per annum.

Taking into account the importance of our commercial, military, and Imperial relations with India, it would be difficult to form an adequate estimate of the money value of a saving of ten days in every double journey performed between Great Britain and India, in time of peace—and in war-time the value of this advantage would be incalculable.

It would be equally difficult to form any just conception of the significance and importance of the fact that the Euphrates Valley Railway, as an alternative route to India, would place us in a position to be independent, not only commercially, but politically, of the Suez Canal route, and of Egypt.

All the great European powers claim to have interests in Egypt which might at any time come into conflict with British interests, and oblige us to defend our, at present, only practicable route to India by force of arms.

With the Euphrates Valley Railway opened as an alternative route, the danger of such a war being forced upon us in self-defence would no longer exist.

In the event of a war with one of the great European Powers, in defence of our route through Egypt to India, the cost would probably not be less than from 100 to 200 millions sterling, and this enormous risk might be avoided by the construction of the Euphrates Valley Railway, at a cost only of £8,000,000 for a single line, or £12,000,000 for a double line of railway; which money would be expended in the interest of peace and civilisation, and would no doubt produce such a dividend as would make the enterprise a profitable one to this country.

THE INJECTOR HYDRANT FOR FIRE EXTINCTION.*

By J. H. Greathead, M.Inst. C.E.

It is calculated that the fire loss in the metropolis last year exceeded two-and-a-quarter millions sterling, equal to 1s. 6d. in the pound on the present annual rateable value of property; and that of this sum, probably, at least one million would have been saved by a system of hydrants with an adequate water supply, such as those which have existed for many years in Liverpool, Manchester, and Glasgow.

The water supply of London, however, although satisfactory as to quantity, has not sufficient pressure for hydrant purposes, and from the fact that the supply has to be pumped up from a low level, instead of coming by gravitation from high sources—as in the towns referred to—it is impossible, without enormous expenditure, to adapt it for hydrants.

Proposals have been made from time to time for improving the supply, or for introducing separate supplies for fire extinction; but these have been objected to on account of the cost involved, or for other reasons.

At present the requisite pressure for jets is given by the pumps of fire-engines. Where, however, efficiency depends upon the power being available immediately the occasion for its use is discovered, this mode of supplying it is eminently unsuitable.

Sir William Armstrong's accumulator system of hydraulic power, generally in use at the docks and goods termini, requires no description. In connection with the injector hydrant, it has been found to be specially applicable to the production of jets of water for fire extinction in cases where the ordinary supply has not sufficient pressure for the purpose. Applied to the metropolis generally in the same way, it would furnish a complete and efficient system of fire-hydrants, without imposing upon the ratepayers any additional burden; and if the hydraulic power were applied to commercial purposes, there would result a considerable gain to them. The system could be introduced at once, either generally or locally, because it is not dependant on any question of improved water supply, and would interfere with no rights or interests.

THE FIRE RISKS OF ELECTRIC LIGHTING.*

By Killingworth Hedges.

There is a great difference between the electric currents which have been in constant use for telegraphic purposes, and those which are to be supplied by the undertakers under the Electric Lighting Act. The latter can only be said to be free from danger when the heat generated by the current is utilised in its right place, and not developed in the conductors or wires which lead the electricity to the incandescent lamps.

The Fire Risk Committee have already issued rules for the guidance of users of electric light; these can hardly be said to embrace all the salient points of the new subject, which can only be arrived at after years of practical work. The necessity of proper regulations has already been recognised by the insurance offices, both in the United States and Germany, and some of their special rules are given in this paper.

The conductors must be properly proportioned for the current they have to carry; whatever resistance there is in the conductor will cause a corresponding development of heat, which will vary with the amount of electricity passing, and inversely as the sectional area.

The material must be free from impurity, otherwise an impure section will increase the resistance. The extraordinary difference in the conducting power of a sample of "commercial" Rio Tinto copper wire, as compared with the pure metal, was shown in an experiment by Dr. Matthiessen—the conducting power being only 13·6 as against 99·95 for pure copper.

The continued heating of an impure metallic conductor has a certain effect on its electrical resistance. With the sample just mentioned, the conducting power at 100° C. decreased from 13·58 to 13·558 after the wire had been heated for three days. It does not always follow that there will be a decrease in the conducting power, as, with alloys, the opposite effect is produced. A copper-silver alloy showed an increase of ·264, after having been heated to 100° C. for three days, and a tin-copper alloy an increase of ·13.

As the temperature in Dr. Matthiessen's experiments was not increased over 100° C., the author has made some further experiments—heating the wires by the electric current from a secondary battery, to within a few degrees of their melting-point.

The following materials were tried—the wires and foils having such sectional area, and so arranged that, on the current being increased by twenty per cent., they were immediately fused.

The total length of each experiment was twenty-four hours, during which time the current passing through varied slightly, and the following is a mean of the results:—

Material.	Resistance before heating.	Resistance of leads.	Difference after 24 hours.
	Ohms.	Ohms.	
No. 1. Commercial tin wire ...	·815	·8	— ·001
„ 2. Lead, soft	·835	·8	— ·001
„ 3. Copper, soft	·81	·8	No change
„ 4. Pure tinfoil.....	·86	·8	No change
„ 5. Tin and lead alloy	·87	·8	— ·001
„ 6. Albo alloy, in foil.....	·835	·8	No change
„ 7. Aluminium and tin alloy	·82	·8	+ ·0008

* Abstract of a paper read before Section G of the British Association, at Southport.

The resistances were in all cases taken at the temperature of the air, which averaged 69°.

The sign — shows that the metal decreased in resistance, and + that it increased after continued heating. Nos. 1 and 3, tin and copper, were found to scale when heated.

A change has been noticed where high tension currents have been sent through a pure copper wire for some time—the wire in the armature of a Siemens' machine, which came under the notice of the author, appeared to be brittle, and gave a fracture unlike pure copper.

The necessity of good electrical connections is very great, also special arrangements of switches and contact breakers which, when left in unskilled hands, are liable to cause dangerous heating or an arc.

Short circuit is the danger which may be caused by badly arranged wires; most likely a conflagration will ensue unless the remedy suggested by the Fire Risk Committee and the Board of Trade is adopted—of having a cut-out or fusible plug in the circuit, which gives way when the current is in excess. These should be arranged to melt if the current is more than 10 or 15 per cent. of the working strength, otherwise absolute safety is not arrived at. Ordinary lead or tin wire cannot be used except for very small currents, as, on fusing, the metal is scattered in a globular form, when it is liable to cause fire. The plan adopted by the author is to take pieces of foil arranged like the leaves of a book; the thinness of the foil causes it to be almost volatilised when melted. The material found to be the most reliable is a special alloy of aluminium, termed Albo metal, which is extremely tough, and can be worked much nearer to its fusing point than tin or lead.

The safety of an electric light installation is only insured by testing, which should be done by a current of higher electro-motive force than it is intended to use.

When the work has been properly supervised no trouble should be experienced, and the electric light may be said to be much safer than gas, as it is free from those accidents which are due to a servant's carelessness, or by leakage of the pipes. Whatever danger there is with electric lighting is entirely localised to the generating station, where the dynamos and engines would be under constant supervision.

BRITISH ASSOCIATION PATENT-LAW COMMITTEE'S REPORT, SE , 1883.

The fact that an Act for the reform of the Patent-laws was passed in the Session just concluded, has of necessity thrown a good deal of work upon the Committee. It has met five times, and nearly every member of it was present at one or more of the meetings. The following gentlemen have been added:—Sir John Lubbock, Mr. Alfred Carpmael, Mr. R. E. Webster, Q.C., and Mr. Theodore Aston, Q.C.

Besides the Government Bill, which was introduced on the 19th February, the Bill prepared by the Society of Arts, and referred to in previous reports of this Committee (see British Association "Report," 1881, p. 222, and 1882, p. 310), was again introduced by Sir John Lubbock, and Mr. Anderson also introduced a Bill generally similar to those he has brought forward in former years. The last two Bills were read a second time, but were not further proceeded with. After the second reading of the Government Bill, it was referred to the Grand Committee on Trade, by which some alterations of a more or less important character were made. The final stages were run through rather rapidly, and, in one of the last weeks of the Session it passed through the House of Lords. The speed with which, after the long delay in the earlier part of the Session, the Bill was carried through Parliament, rendered it by no means easy to obtain amendment in it, and indeed the risk of the Bill not passing if many changes were introduced, afforded a reason to the President of the Board of Trade for not accepting many alterations pressed upon him from various quarters.

It does not appear desirable to lengthen this report by giving an abstract of the Bill, since its main provisions have already been published in the technical newspapers and elsewhere. An excellent summary is to be found in the Society of Arts *Journal* for September 7th, 1883.

The Committee felt that the Government Bill compared unfavourably with that of the Society of Arts, and this opinion was shared in many other quarters. Had the Government consented to accept that Bill, or had they, at all events, been willing to adopt certain of its provisions, the Committee believe that a much better measure would have resulted than they have any reason to hope the present Act will prove to be. On the whole, they are not sanguine as to any very beneficial results from the new law. The reduction of cost in the earlier stages of a patent has ensured the popularity of the Act in certain quarters, but it remains to be seen how far the actual process will be cheapened, and to what extent the new provisions for opposition, &c., will entail counter-balancing expenses. The substitution of a single working head, instead of *ex-officio* Commissioners, is an obvious advantage, but the reform has not gone nearly far enough, for the new "Controller" is to be a mere departmental official subordinate to several distinct authorities, instead of possessing independent power. The provisions for applications for patents contain some minor improvements. A British patent is no longer to be affected by the duration of a corresponding foreign patent. The practice of "racing for the Seal," trying to get a later application sealed before an earlier one, is abolished. The system proposed for the examination of specifications is incomplete, and will probably be found to be of slight value, while it is very likely to give considerable additional trouble to the inventor. The provisions for opposition appear most objectionable, and will certainly

press very hardly on the poorer class of inventors. Those for amendment and disclaimer are improvements on the present system. That the jurisdiction of the Privy Council in the question of the extension of patents is preserved, appears to the Committee a matter for regret. The position of inventors as regards the Crown is somewhat improved, but it is manifestly unfair that the Treasury should be the tribunal to decide upon the terms on which the Crown may use inventions.

This Committee co-operated with the Patent Committee of the Society of Arts in endeavouring to improve the Bill, and in order to bring their views before the Government, they sought interviews with the President of the Board of Trade, and with the Lord Chancellor; they believe their efforts have not been without good result. On both occasions time did not admit of their asking the sanction of the Council of the Association, and they therefore were obliged to go as a Committee merely, and not as representing the Association, or with the authority such sanction would have given, had it been obtained. Care was taken that this was definitely stated.

The Committee think it well that they should be re-appointed for the purpose of watching and reporting upon the working of the new Act.

The Committee would be glad if they could be allowed a grant of £5 to cover the various expenses, which otherwise (as in the past year) have to be defrayed by individual members.

THE FISHERIES EXHIBITION.

No. IV.

A special feature in the display at South Kensington are the models and drawings of fishing vessels, and the boats themselves employed by British fishermen and those of other nations. The forms, different styles, rigs, and outfits of vessels and boats employed in sea-fishing at home and abroad is a study in itself, and one of the most interesting departments of a Fisheries Exhibition to those learned in the lore of the deep, and also to unscientific visitors. Nor is this a matter for surprise, when it is remembered that, with the exception of the comparatively small quantity of fish caught in seine-nets from the beach, or near the shore, the whole of the British and foreign markets are supplied with fish, for the capture of which vessels of one kind or another are required.

The type, and to a great extent the size, of vessels are determined by the accommodation for them when at home. For instance, where there are no harbours, and fishing craft have to be beached, they must have flatter bottoms and less keel than in places where they can lie at anchor in deep water. Another consideration is the kind of fishing in which a vessel is to be employed. Hence, round our coasts we find an almost infinite variety of vessels, suited more or less to the locality from which they hail, and the special work required of them. The staunch little oak-built craft, for instance, which hail from Mount's Bay, St. Ives, and other places in Cornwall, and go fearlessly and safely through the boiling tidal sea off Land's End, and away to the fishing grounds in the neighbourhood of "the Wolf," are suited to the locality. But they would hardly be judged fit craft for the North Sea work, though one of the type once voyaged out from Penzance to Australia. The fine smacks which rendezvous at Brixham and Plymouth are perfect specimens of Channel trawlers. Dover boasts of many fine smacks and admirable luggers, and from Ramsgate some grand specimens of vessels sail away for the Doggerbank. Lowestoft, Yarmouth, Hull, Grimsby, Filey, and Scarborough, have a mixed collection of craft, admirably fitted for the work required of them, while the "cobles" in use further north are really wonderful fabrics of the boat kind. The large type of Scotch lugger is a note-worthy specimen of fishing craft, and when sailing along the wind in a hard breeze, can rival in speed fast yachts. The Welsh and Bristol Channel contingents form a heterogeneous collection, but though some excellent boats are to be found among them, they do not hold a leading position in the industry. The prolific banks down the eastern coast of Ireland are not worked as much as they might be; but there is often an imposing show of fine boats in the upper part of Kingstown harbour. Of late years our fisher fleets have, as a rule, improved in model and rig all round our coasts, and it may be noted that, where the locality permits, there is a growing tendency to build fishing vessels more for speed than formerly, the old bluff bows being replaced with sharp ones, and "fine lines" being dominant. Moreover, the necessity in recent times to fish at longer distances from the land, and to remain out at sea a longer time, has led to the building of fishing vessels of a larger size, and with improved construction, so that they may be capable of facing the bad weather to which they are sure, sooner or later, to be exposed. Even in the smaller boats, more commonly employed in drift fishing, the advantage of their being decked is daily becoming more evident; for they can stand worse weather, and, therefore, can risk going further to sea and seeking the shoals of fish where formerly they dared not venture.

The most important improvement in connection with fishing craft is the employment of steam power; and it is applied in various ways, although the additional expense incurred interfered for some time with even its present partial adoption. Its advantage, however, is very great, enabling, as it does, the fishing boats to go to, and return quickly from, their fishing grounds, saving both time and labour in hauling their nets, and especially in the case of deep-sea trawling, where fast steam "carriers" collect the fish from a fleet of trawlers, and make the best of their way with it to the nearest market. Whether used as a partial substitute for sails, for economising

labour on board ship, or securing a quick delivery of the fish at market, the application of steam to fishing vessels must be regarded as one of the most important steps yet taken in the development of our deep-sea fisheries. The sea-going character of so many of our fishing vessels obliges them also to be fitted out with more elaborate appliances than were ever thought of by the simple-minded fishermen of little more than a generation back. They have now to deal with everything on a larger scale, and they find the benefit of numerous inventions and recent improvements in capstans—which are often worked by steam—compasses, lights, steering gear, barometers, and a whole host of other appliances fully illustrated by the exhibits at South Kensington. Thus they are helped to do their work more easily, and to take better precautions than formerly against the many dangers to which they are exposed.

Some types of our ordinary fishing vessels must now be mentioned. Those used for trawling have long been known as "smacks," from their smack or cutter rig. Forty or fifty years ago they were of comparatively small size, ranging from twenty to forty tons. They were stoutly built craft, able to hold their own in almost any weather, but rather slow sailers. The improvements in modern shipbuilding have not been lost sight of; and the great and increasing demand for fish has led to the construction of larger trawlers, capable of working much heavier nets, and capable of increased speed. A larger mainsail required in these smacks, which now are often of seventy or eighty tons, has necessitated a modification of their rig, so as to avoid a heavier boom, which would, in bad weather, strain everything to the utmost. This sail has accordingly been reduced in size, and a mizenmast has been added, on which a small gaff-sail is carried. The new vessels are also built of greater proportionate length than formerly; so that, with the change in rig, the great pressure of the sails is brought lower, making the vessel easier in a seaway, and more readily handled. These vessels are what are called "ketch-rigged," and the change is generally adopted in the new trawlers at the North Sea stations and at Brixham. The cost of trawl smacks has greatly increased of late years, not only on account of their larger size, but because of the higher price which has to be paid for almost everything connected with their construction. About twenty-five years ago a new trawler, ready for sea, and what was then considered one of the larger class, could be built and fitted out for £700 or £800, but the new class of vessels now cannot be turned out for less than £1,200.

A cod smack, used in long-line fishing, described in the last article, is still more expensive, one of eighty tons register costing from £1,600 to £1,800; and, of course, considerably more according to increased tonnage, which in some cases is registered as high as 120. Cod smacks are "fore-and-aft dandy-rigged vessels, with foremast and mizenmast;" their usual dimensions are sixty to seventy feet length of keel, twenty to twenty-one feet beam, and about eleven feet depth amidships; and in ordinary ballast they draw about eleven feet of water aft, and about seven feet forward. They are built principally of oak; as a rule they are fast sailers, and their sea-going qualities cannot be surpassed. In the centre of the vessel a space of nearly one-third of the length of the keel is set apart for the well. This is divided off by strong bulkheads, and the whole compartment is again divided by one or two sectional bulkheads, thus forming two or three wells, as the case may be. It is to this "well" arrangement we owe our constant supply of "live cod," as before referred to.

The Yarmouth vessels may be taken as the best types of those employed in the drift-net business. They are all decked, and the largest of them measure about thirty-six tons, being fifty-two feet on the keel, with seventeen feet beam, and seven feet depth of hold. They are lugger rigged, with two masts, and carry a jib, a large dipping fore-lug, and a working mizen and topsail. The mizenmast is always kept standing; but to enable the vessel to ride easier when fishing, the large foremast is fitted so as to lower backwards, on the same principle as that applied to barges which have to pass under bridges. The mast on these Yarmouth luggers, however, is not lowered completely on deck, where it would be very much in the way when the nets are being hauled in, but is supported about the middle by a kind of "crutch," which holds it up a sufficient height from the deck to enable the crew to work under it. The same kind of support for the mast is used in all drift-fishing boats of any size, whether decked or open.

From Flamborough northward, nearly as far as Holy Island, the peculiar boats called "cobles" are in regular use. They vary a good deal in size, but are all built on one principle, and with one object—that of readily beaching, stern foremost, in a surf. The bow is built with a considerable rise, and is sharp and hollow below, but the keel extends only for a little more than half the length of the boat. The after part of the bottom is flat, with a runner of false keel on each side of the central plank, and carried so far forward as to overlap the end of the true keel from the bow. The result is that the coble can be backed up with great facility on the beach, the flat keel-plank and false keels keeping her steady and upright, whilst the hollow bow throws off the waves which may be beating her on the shore. These boats are built with broad planks, and the two upper ones "tumble in" at the quarters, giving the stern a "boxed-in" appearance. They are very useful boats, and will stand a good deal of bad weather, but are rather dangerous when running before a sea. The fashion has long been to paint the cobles in stripes of yellow, green, and red, thus giving a still more quaint appearance to these peculiarly-constructed boats.

The Shetland Isles boats are mainly used in the long-line fishing for ling and tusk. They are open boats called "haaf," or deep-sea boats, which have

long been famous for their seaworthy qualities. These are the true "Norway yawls," having very much the build and character of whale-boats, and they are handled in a wonderful manner by the Shetlanders, who show, in their love for the sea, and by their daring and energy in their work on it, that they are still worthy of their descent from the Norsemen, of which they are so proud. These skiffs are about twenty feet on the keel, twenty-eight feet over all, and with eight feet beam. They carry a single large lug. The Manx boats for deep-sea work are fine craft, from forty to fifty feet in length, half-decked, but can be entirely covered in when necessary. They are mostly dandy-rigged, the older rig with the dipping lug gradually becoming obsolete. They are wonderful sea boats, and, unlike many east coast boats, have flush decks fore and aft.

The boats or "cots" used in the drift-net herring fishery at Wexford, in Ireland, are amongst those which claim attention, as being of a peculiar build. They are sharp at both ends, and entirely flat-bottomed, with the exception of a small bit of keel at the bow and stern, and a false keel or bilge piece extending some distance on each side between the floor and the planking. They are about thirty feet over all, and with seven or eight feet beam. A centre-board, with a depth of five feet below the floor, is lowered when the boat is on a wind. The sails consist of three sprit-sails and a jib. These boats are well suited for working their way over shoals, such as those inside and outside Wexford harbour. It is a matter for regret that fishing vessels in many Irish districts show but little improvement of late years; and many of them, as exhibited at South Kensington, may almost be classed as "curiosities." At Dingle, and on part of the coast northward, a remarkable kind of fishing-boat is in common use; namely, the "curragh," or canvas canoe. The construction of these curraghs is very simple, consisting of a light wooden frame for the top sides, strengthened by a keelson curved slightly upwards at each end to form the stern and stern-post. The ribs are pieces of cask hoop, cut to such a length to give the requisite curve to the bottom; and outside these are nailed long narrow battens to serve as flooring. Over this skeleton, pieces of tarred canvas are nailed, each strip about two feet wide, and extending round the bottom from one gunwale to the other. Thwarts are fixed in the usual manner, and the craft is propelled by three or four pairs of light oars. These curraghs float like bubbles on the water when empty; but with four men in them, each using a pair of oars, they are easily managed, and will go through much more bad weather than might be expected. They are about twenty feet long, and four feet wide; and are chiefly used for line-fishing.

The most important of the foreign exhibits in the department of which we have been speaking, are those from the United States. The collection of models is very complete, and should on no account be missed by the visitor. The majority of the American deep-sea fishing vessels are larger than our own, and are almost invariably schooner-rigged. The American fishing craft is nothing, if not fast, so they are built on lines as fine as those of a yacht, in fact, it is said that, given a stiff breeze, they will, in many instances beat yachts. They are heavily canvassed, too, and the booms of the mainsail project so far over the stern, that in some vessels they are actually along at the middle of their length. But in the opinion of many good judges, there is one defect in American vessels, not existing on this side of the Atlantic, and that is, a deficiency of depth. This defect, it may be noted, arises from a peculiar reason. In America ships are built by what is there known as "carpenter's tonnage," and directly you come to depth, this materially increases the expense; so, to save money, depth is sacrificed, and extra beam given instead—beam, for some reason or other, being cheaper than depth. Some of the cod and halibut boats are as much as 160 tons, and 90 and 100 tons seems a common size. The latter carry a crew of fourteen or sixteen, the liberal way in which the vessels are canvassed necessitating a full complement of hands. The Newfoundland vessels, like the American, are built for speed, as far as fine lines are compatible with roominess, and some of the models show that these two qualities have had a fight for supremacy. One of them is a brigantine—that is a vessel square-rigged on the foremast, and schooner-rigged on the main-mast—used in seal fishery. A curious rig is seen in the Danish section, in a Faroese whale-boat. There is but one sail, a very long lug on a correspondingly long yard; it reaches almost from one end of the boat to the other; while the mast is stepped nearly in the centre of the boat's length, giving it a peculiar look to English eyes. On passing into the Belgian section, we find a smack used by the Heyst fishermen, built after a very antiquated form, the bows being as bluff as those of a coal barge, the sides fitted with large lee boards, and the rig a peculiar square one. Safe and good sea boats they probably are, but must be very slow, particularly on a wind. The Norwegian section is interesting, if only on account of the model of the Viking ship, with its graceful lines; but there are plenty of others, arranged in the centre of the department, on a mimic sea. The Norwegians employ a great many small boats. Some of them are shaped with both ends alike; others have large square sterns, that one would think must cause a great suck, and stop their speed. The larger vessels have a peculiar sail, quite oblong in shape, and kept in place by a sprit, though it differs from the English sprit-sail in being quite straight from what we should call the peak to the lower end. Beyond mentioning that the Chinese vessels do not seem built for speed, and that the sails are square, and made of matting, there is not much to be said. Though, perhaps, British fishermen may not find very much to learn, generally, from the models shown of fishing vessels and boats in the foreign sections of the Exhibition, still they may gain some useful practical hints in detail from

some of them, and with this end in view, the American section will be found most profitable.

It may fairly be anticipated that one result of the Fisheries Exhibition will be to impress on the community in general the dietetic value of fish, and its relation to other nutritive substances incommon use.

The varieties of fish which are used as food throughout the world are almost infinite. No fewer than forty-five are quoted by Dr. H. Simpson as eaten in only one locality in India, viz., Dacca. Among those denizens of the sea with which we are best acquainted are cod, ling, plaice, turbot, sole, sturgeon, haddock, whiting, herring, sprat, mackerel, pilchard, mullet (red and grey), skate, halibut, smelt, gurnard, shad, and sea bream, to which salmon may fairly be added. The use of fish is, doubtless, greatest in those countries where it is the most readily caught, and where poverty so abounds that many can obtain only that kind of flesh. This is particularly the case in many parts of India, the Mediterranean coast of Spain, and the western coast of Ireland. Many kinds of fish were eaten in this country in the fourteenth century, as the sturgeon, salmon, pike, haddock, cod, roach, tench, turbot, plaice, eel, the conger-eel, mackerel, sole, lamprey, &c.; and, though this has been doubted, recipes for the cooking of them at that period still exist.

It is said that a fish-eating people are ill-nourished, and in eastern countries are particularly liable to become leprous. If this be so, it must be associated with such poverty as prevents the inhabitants from obtaining a proper variety of flesh food and vegetables. Certain districts on the Mediterranean coast of Spain are cited in illustration of these facts, where there is a fish-eating and a poverty-stricken population; and if we turn to another fish-eating community—that of parts of the west coast of Norway—we find the disease; although some of the people are characterised by robustness of health and great physical strength. In the latter case, however, the consumed fish is chiefly the red-blooded salmon, which approximates in character to the flesh of the mammalia, and there is not an universal exclusion of ordinary flesh from their dietary. It is not desirable that fish should be the sole kind of nitrogenous animal food eaten by any nation; and, even if milk and eggs be added thereto, the vigour of such a people is not likely to be equal to that of flesh-eating communities.

Fish are generally divided, for the purposes of food, into two classes, viz.—white-blooded and red-blooded, of which cod may represent the former, and salmon the latter. Fish vary in flavour, not only on this ground, but from the presence of oil in the flesh; so that some kinds of fish, as the sole, contain but little, whilst others, as the eel, contain much. Moreover, in some, as the salmon, the oil is distributed throughout the muscular tissue, whilst in others it is stored up in the liver, as in the cod. As a general statement, it may be said that the flesh of white fish contains far less oil than that of red fish. It is therefore evident that, whilst the term fish may be applicable to an infinite number of creatures, it represents very different nutritive values—a difference far greater than exists in the flesh of the mammalia—and it is very difficult to give an adequate expression by simply stating the composition of one or two specimens. The effect of white fish upon the vital functions is much less than that of the flesh of the mammalia, and is probably less than that of poultry. The nutritive value of the flesh of a red-blood fish, as salmon, is said to differ but little from that of the red-blood flesh of other animals.

The market value of fish differs extremely with the season, weather, and kind of fish; but, under ordinary circumstances, fresh herring offers the largest amount of nutriment for a given sum of money, of any kind of animal food. Hence, herring is of great value to the poor man, whilst salmon, which, centuries ago, in some districts was the poor man's food, is of all fish the most to be desired for the richer classes; and whilst the former is abundant without the aid of man, the latter demands the protection of the law that it may increase. The cost of the former is scarcely under the control of man, whilst that of the latter may be greatly reduced as the supply increases. The high proportion of nitrogenous matter in mackerel also shows how valuable a fish it is. A shilling spent on mackerel will go much further than a shilling spent in beef, reckoning at present prices. There can be little doubt that the flesh of fish, so far as chemistry tells us, is nearly as useful for diet as the flesh of many commonly used animals is.

Sir Henry Thompson, in his paper read at the Fisheries Exhibition, says that, though fish is an inhabitant of water, and cannot live out of it, the proportion of that element in the animal's structure exceeds only by a small amount the proportion which is present in land animals. In other words, the solid constituents of fish as a class, though there are important exceptions here and there, are but little less in weight than those of the flesh of cattle which we are in the habit of eating. In 100lbs. of fish without bone, from 75 to 85 are water, or rather more than three-quarters of the whole, leaving, say, about 20 lbs. of solids as a mean estimate. Of these about 12 to 18 lbs. are nitrogenous compounds.

It must, however, be remembered that men who have daily to undergo a large amount of physical and exhausting bodily labour, require much more nitrogenous food than is supplied by an exclusively fish diet. But, on the other hand, a very large proportion of fish food is highly advantageous for certain classes of persons, who do not require the quantity of nitrogen supplied by meat. It is for the large and increasing class of the community who are emphatically brain-workers, that fish furnishes an appropriate food; and when we reflect that the tendency of civilisation is slowly but surely to develop mental activity, and to dispense with laborious handicraft, and all that

advance in individual as well as corporate well-being is commensurate with, and indeed is effected by, the substitution of brain-work for mechanical labour, we may more fully appreciate the value of fish as food. For the sedentary man, whatever his calling in life, whose engagements permit him only to take just that moderate amount of muscular exercise which is, in all circumstances, essential to health; and for a great proportion of women, whose habits mostly are not, and often cannot be active, the nutritive elements afforded by fish admirably supply an important part of the wants of the body. The moderate amount of flesh-forming material present in fish, and in a form which entails little labour on the digestive organs, and the facility with which fish may be associated with other elements —fatty matters or cereal and vegetable products— place it in the first rank of foods in that mixed dietary which is suitable to those who lead more or less the kind of life referred to. Sir Henry Thompson does not, indeed, uphold the view which has recently been strongly urged and widely entertained, viz., that fish contains certain elements, and especially phosphorus, which is adapted in an especial manner to renovate the brain, and so to support mental labour; but he bases his advocacy of the value of fish to the brain-worker, and many other persons under certain circumstances, on the fact already referred to, namely, that it contains, in smaller proportions than meat, those materials which, taken abundantly, demand much physical labour for their complete consumption, and which, without this, produce an unhealthy condition of body, more or less incompatible with the easy and active exercise of the functions of the brain. It is on the ground of its easiness of digestion, without the necessity of much bodily exercise, that fish constitutes a most admirable element in the diet of the aged.

The Exhibition has set everyone talking about fish, and has led many persons to make gastronomic experiments on certain fish, from which they had hitherto turned away. The conger, and the wolf or cat-fish for instance, have been recently tried by thousands of persons, at least in the South of England, who previously had never tasted them, and they have been highly approved of. Cat-fish are largely eaten by the mining population of the northern and midland counties. There are many other fish, too, which might be experimented on, and tested by a variety of methods of cookery. If there were established in large cities and towns gastronomic clubs, similar to the Ichthyophagous Club, of New York, these might be the means of disseminating much information concerning fish as food? The club just mentioned seems a very enterprising association, and has been the means of introducing many new fish to the American public. In England the number of fish available for the table, although far greater than the public in general is aware of, is limited in comparison with the extraordinary variety which an American fish-eater can select from. The bill of fare of a recent dinner of the club just mentioned, extensive as it is, gives but a slight idea of the number of edible fish in American waters; and, indeed, as the club was bent upon novelties, none of the names of the many excellent fish which find their place upon the *carte* of an ordinary American hotel dinner are to be found in the list. The following is the *menu* alluded to :—

Little Neck clams.

POTAGES.

Cosommé of shark-fin à la chinoise.
Purée of bull-frog à la [illegible].

HORS D'ŒUVRE.

Razor clams farcis à la Nelson.
Tartelettes of horse-shoe crabs à la [illegible].
Sardines, olives, and Anchovies.

RELEVES.

Moonfish à l'Espagnole. Kennebec salmon garni à la [illegible].
Green peas. Potatoes à l'Amsterdam.

ENTREES.

Soufflé of Long Island brook-trout à l'Impératrice.
Squid farci à la gourmande. White bait à la [illegible].
Cauliflower au gratin. String beans.

ROTIS.

Swordfish piqué à la Chambord. Wolffish sur socle à la [illegible].
Garfish à la provencale.
Sorbet au Kirsch.

GIBIER.

Sea robins. Lettuce salad.

PIECES FROIDES.

Aspic of Spanish mackerel à la Normande.
Sturgeon sur socle à beurre Montpellier.

It may be fairly hoped that the Exhibition will lead to further experiments on the gastronomic value of fish; and it is to be hoped that those who are striving to turn the South Kensington display to a practical advantage, will include the spreading a knowledge of the value of fish food in their endeavours.

CINCHONA CULTIVATION IN BENGAL.

It appears from the Annual Report of the Government Cinchona Plantation in Bengal, for the year 1882-83, that the progress made has been most satisfactory. The crop of the year is the largest that has yet been harvested on the plantations, and, moreover, the price of the febrifuge produced has been lower than in any former year, owing to the large percentage of alkaloids extracted from the bark used in manufacture. On the other hand, the result of the planting operations of the year shows a decrease of about 50,000 cinchona trees on the returns of 1881-82, due to the uprooting of a large number of the *Calisaya* and hybrid varieties, which were found to possess bark of poor quality. In conformity with the same policy of raising the standard of the produce of these estates, that caused the removal of these inferior trees, 160,085 red bark trees, which had to be

uprooted in the ordinary rotation followed on the plantation, were replaced, not by red barks, but by yellow barks and hybrids. Arrangements are made for the planting out of a number of the best kinds of *Ledgeriana* and hybrid cinchonas at Ranjung, in the new cinchona preserve across the Teesta. Dr. King, the superintendent, has had analyses made of eight distinct forms of hybrid cinchona trees, and he points out that No. 4 of these is very poor in quinine, while No. 7 appears to be exceptionally rich. The trees uprooted during the year belonged to class No. 4, and those now being planted to No. 7. The total number of cinchona trees of all sorts, at the close of the year, was 4,711,168; namely, red (*Cinchona succirubra*), 3,713,200; yellow (*Calisaya ledgeriana*), 662,998; hybrid, unnamed variety, 304,378; and other kinds, 30,592.

As already stated, the crop of the year is the largest that has yet been harvested. It amounted to 396,980 lbs. of dry bark, of which 372,610 lbs. were of *Succirubra*, 22,120 lbs. of *Calisaya* and *Ledgeriana*, and 2,250 lbs. of hybrid bark. By far the largest portion of the produce was made over to the factory for conversion into cinchona febrifuge, while about 41,800 lbs. of yellow and red barks were sent, at the request of the Secretary of State, to London, to be there converted into various forms of febrifuge, and returned to India for trial by the medical departments. Dr. King says in his report, "I regret to have to record the continued failure of *Carthagena* bark, only three plants being alive at the end of the year. Nothing could well have been more disappointing than has been the attempt to introduce this bark. The plants received from Kew at first grew vigorously, and it appeared as if the species would be easy of cultivation; gradually, however, all the plants sickened. Every care was taken of them by Mr. Gammie, individual plants were tried at various elevations, and with various exposures, but the results have been uniformly disappointing." With regard to *Cuprea* bark, Dr. King reports:—"Some years ago a quinine yielding bark, under the name of *Cuprea*, began to be poured into the London market from the northern part of South America. The supplies of this have steadily increased until now, *Cuprea* forms a very large proportion of the quinine bark imported into Europe. At first the botanical origin of *Cuprea* was unknown, but it has now been ascertained to be the produce of a species of *Remija*, a genus botanically allied to cinchona. *Remija* is said to be less particular as to soil and climate, and it is not unlikely that it may be possible to cultivate it in this country. I have, therefore, been anxiously trying for some time to get seed of *Remija*. I regret, however, to say that from the only packet which I have been able to secure, only a single seedling has resulted. Further efforts shall, however, be made to secure seed, and I hope before long to have a patch of *Remija* trees added to the plantation." The crop for 1883-84 is estimated to produce about 350,000 lbs. of dry bark, and the stock of febrifuge on hand at the end of the year 1882-83 was 2,962½ lbs.; this is nearly double the amount of the previous year, which was only 1,500½ lbs., but it is not thought to be too much, as it is only equal to about four months' consumption. The revenue derived from the sale of the febrifuge, seed plants, and bark, amounted to Rs.1,52,807 1a., and the operations of the year resulted in a profit of Rs.66,284 9a. 5p., which is equal to a dividend of 6½d. per cent. on the capital outlay. It is stated that the total saving effected since the opening of the factory by the substitution of the febrifuge for sulphate of quinine amounts to 23¼ lakhs of rupees, or more than twice the amount of the cost of the plantations.

Improvements have been made in the manufacture, by which a larger percentage of alkaloids is extracted from the bark, but, according to the report, the present system is admittedly wasteful, in that it fails to convert into febrifuge the whole of the alkaloids which the bark contains, while there is no doubt that, by the adoption of a different and more costly process of manufacture, a still larger per-centage of the medicinal alkaloids could be extracted. It is not, however, equally certain whether the febrifuge so obtained could be turned out at a less cost per pound. The whole subject of the course to be adopted in the disposal of the raw produce of the plantations is still under the consideration of Government.

Dr. King has succeeded in obtaining an analysis of the bark renewed on *Succirubra* trees that had their original bark removed by the shaving process introduced hy Mr. Moens, the distinguished Director of Cinchona Cultivation to the Dutch Government. It appears that this process consists in shaving off the greater part of a living tree to the height of from eight to ten feet from the ground, care being taken to leave everywhere a sufficiently thick layer of bark to cover the wood. This method has had a fair trial on the Sikkim plantations, and the result has been favourable, as the bark renews perfectly. What, however, remained to be seen was whether the renewed bark was as rich in medicinal alkaloids as the original. The results are thus described by Dr. King:—"The bark renewed rather slowly, but the analysis shows that it is very rich both in quinine and cinchonidine; and there can be no doubt that in countries where red bark trees are perfectly at home, and where their continuance in good health and vigour for a long series of years can be absolutely counted on, this shaving process must be a very excellent one."

Thanks are given by the Lieutenant-Governor of Bengal to Dr. King, "whose management of his department leaves nothing to be desired."

GRAPE CULTURE AND WINE MAKING IN RUSSIA.

Consul-General Stanton, in his last report on the commerce and industries of Russia, says that along the shores of the Black Sea, Sea of Azof, and on both

sides of the Caucasian Mountains, there is a vast territory devoted to the culture of the grape. Astrakan may be considered as the home of Russian grape culture, since the first vines were planted there at the beginning of the seventeenth century. In Trans-Caucasia the culture of the vine dates back to time immemorial, and the opinion prevails that the diffusion of the vine throughout Europe proceeded from this country. In the Taurida peninsula and modern Bessarabia the grape culture owes its origin to the Grecian colonies, founded there some six centuries before the Christian era. Old Grecian amphoræ, which have been found on the banks of the Don, justify the inference that the Greeks extended the culture of the grape to these districts also. In the Crimea it attained its prime between the eleventh and fifteenth centuries, under the dominion of the Genoese; under the Tartars, however, it fell into decay, similar to that of the Caucasian districts, under the rule of the Turks and Persians. With the accession of the Russians the industry began to flourish, and was extended by them to the Kuban and Terek districts. In Bessarabia, the culture of the vine extends over the whole Government, and into the bordering districts of the Governments of Kerson and Podolia. In 1870, the yield was 965,250 gallons of wine, while according to official data in 1879, Bessarabia alone produced 18,756,000 gallons. The wines are generally light, the red varieties resembling the French and the white the Rhine wines; the best known are the Ackermann, the Odessa, and those of the Bulgarian Colony. In the Crimea, the only four districts in which the wine industry is of any importance are Yalta, Eupatoria, Simferopol, and Feodosia. Compared with the rest of Russia, grape culture has attained its greatest perfection in the Crimea; the newest methods are adopted, and a large number of vine growers, particularly those on the Southern shores, make and sell their own wines under their own names in St. Petersburg and Moscow. The Government has paid the greatest attention to this industry in the Crimea. In 1812, the Imperial Nikita garden was laid out on the southern shores in the vicinity of Yalta, and in 1828 the Margaratsch school of vine culture was established. In 1868 the Nikita garden was transformed into the Nikita vintage and gardening school, but the Margaratsch school remained unaltered in order that the students of the Nikita Institute might learn grape culture practically. In 1870, 3,037,000 gallons of grape juice were pressed in the Crimea, and the yield has steadily increased since the beginning of the present century. The Crimean vintners pass the grapes through a kind of grater, in order to separate them from the stems, the juice flowing into double bottomed vats, the upper one being perforated, and the berries are then put in the presses which are ordinarily of wood, and of the simplest construction. The must is put into casks, in which it remains twenty-four hours, when it is poured into other casks, where it is allowed to remain twelve days, being kept at a temperature of from 16° to 22° Celsius. When fermentation ceases, the partially emptied casks are refilled. The first transfusion takes place in December, the second and third in March and September. For clarifying, gelatine and isinglass are used, and at times, for red wines, albumen also. The majority of vine growers sell their wine in unfermented and unripe condition to wine dealers, who perfect it and put it into the market. The Don wine district lies in the Government of the Cossacks, and owes its existence to Peter the Great. Until the year 1820 the annual yield did not average more than 65,000 gallons, while in 1870 it exceeded 4,875,000 gallons. The grape growers seldom make any wine themselves, but sell their crops to wine makers who are known as *Vinniki*, who seldom ripen and clarify the wine themselves, but transfer it to the wine dealers for this purpose. Generally the Don wines are light, watery, and do not improve by keeping. In the Caucasus the culture of the grape is carried on in the Kuban, Kumaschia, Terek, and Daghestan districts. The Terek-Kumyksian district produces the greatest quantity and the best quality of Caucasian wine, about 1,625,000 gallons being annually sold at the Nischni-Novgorod fair. Grape pressing in this district is done in vats and troughs with the hands and feet. The must ferments in casks, in which it remains until the autumn, when it is clarified and put in the market. The Kuma district ranks second, and produces annually from 812,000 to 975,000 gallons. The wine of this region is sold after the first fermentation; it is light and watery, and consumed chiefly in the Novgorod and Black Sea districts. In Daghestan about 487,500 gallons of wine is produced, and is chiefly consumed by Caucasian Musselmans. In the Kuban district grape culture is of recent date, and the wine produced is consumed on the spot. In Trans-Caucasia not less than 32,500,000 gallons of wine are annually produced. The province may be divided into five wine-producing districts, the Rion, Black Sea district yielding annually about 10,725,000 gallons; the Kachetian, 9,725,000; the Kura, 4,872,000; the Arax, 3,250,000; and the Shemahka district producing about 325,000 gallons. The best wines are found in the Kachetian and Black Sea districts, where the red wines especially are of good quality. In Kachetia the vintners erect a peculiar style of barn called *maralyen*, in which are placed wooden or stone presses, whose floors slope to an opening for the issue of the wine. Above the press is a beam, to which the labourers cling while treading out the grape juice with their feet. Earthen jars are used as receptacles for the wine. The must first issuing is separated from that resulting from an increased pressure—the former yields a poor and weak, the latter a better and stronger wine. The fermentation takes place in jars; white wines ferment from eight to ten, red wines from three to seven days, when they are transferred to new jars, the lees being used for the distillation of brandy. The wine remains in lightly-closed jars, which are buried in the ground, until

December, when they are hermetically closed, and covered with about two feet of earth. This method of wine-making prevails, with slight alterations, throughout the whole of the Caucasian wine districts. In Trans-Caucasia the wine is transported in goatskin bags, and generally sold in them. The casks are smeared with fat or kerosene, which gives the wine a disagreeable taste. It is estimated that the grape-growing districts of Russia and Caucasia yield annually about 48,750,000 gallons of grape juice, nearly 16,125,000 gallons of which are consumed on the spot, the remainder coming into the general market.

General Notes.

Vegetable Wool.—The *Moniteur des fils et tissus* calls attention to a description of vegetable wool called *Kapoc*. It comes from Java, and a specimen is on view at the Amsterdam Exhibition. It arrives at Amsterdam in its leathery covering, being itself enveloped in the seeds. It is then freed from both, and is carded so as to make a very light mattress wool, worth about 8¾d. per pound. One of the houses engaged in this operation had made trials in spinning and dyeing this material, but the filaments are said to be like strings, and their industrial application consequently a matter of uncertainty.

Nice International Exhibition.—This Exhibition of Agriculture, Industry, and the Fine Arts, is under the patronage of the French Government, the Nice Municipality, the General Council of the Department of Alpes Maritimes, and the Nice Chamber of Commerce. The following are the principal regulations. The Exhibition will be open from 1st December, 1883, to 1st May, 1884. No goods will be admitted after the end of October. The Exhibition building will constitute a bonded warehouse. All French railways and steamboat companies grant a reduction of 50 per cent. on the carriage of goods for exhibition. Every exhibitor must have a representative at Nice. No charge will be made for space in the fine art department; but in the others, the charge will be from 25 fr. to 50 fr. per square metre for ground space; and 15 fr. to 25 fr. for wall space in the main building; 10 fr. to 20 fr. for ground and wall space in the annexes; and 5 fr. to 10 fr. in the open air. No goods may be removed before the close of the Exhibition. Motive power will be supplied gratuitously in the machinery annexe and the *Galerie du Travail* (department of processes shown in practical work); but steam, water, gas, or electricity must be paid for according to consumption.

Yorkshire Coal Mines.—Mr. F. W. Wardell, her Majesty's Inspector of Mines for the district of Yorkshire, in his report for 1882, states that in that year 61,548 persons were employed about the mines, as against 60,531 in 1881, and 18,525,406 tons of coal were raised, as against 18,287,141 tons in 1881. There were last year eighty-seven fatal accidents, causing ninety-five deaths, so that one life was lost to every 648 persons employed. In 1881, there were seventy-five fatal accidents, each causing one death; and there was one life lost to every 807 employed. Last year one life was lost to every 199,812 tons of mineral wrought, whilst in 1881 a life was lost to every 249,376 tons wrought. Viewed in this light, mining in the district appears to have been more dangerous last year. Throughout the kingdom the result is similar, the average loss of life last year being one to every 152,161 tons wrought, as against one to every 177,106 tons wrought in 1881. In Yorkshire there were last year 452 mines at work, whilst in 1881 there were 471, a decrease in the year of nineteen. Mr. Wardell observes that the mines of the district are not fully employed, and that the large output does not show nearly their full limit of production, as last year's total could be largely increased.

Agriculture in Canada.—According to the report of the Minister of Agriculture of Canada, for the year 1882, there was a large increase in the number of pure-bred cattle imported as compared with previous years, the numbers being:—Cattle, 1,215; sheep, 1,124; swine, 1,122. The exports of stock in 1882 were 62,106 cattle, 311,669 sheep, 20,920 horses. The figures in 1881 were 62,277 cattle, 354,155 sheep, 21,993 horses. It may be mentioned that 16,145 cattle went to the United States, and the remainder came principally to Great Britain. The value of the sheep exported represents about $1,400,000. The export of phosphate of lime has largely increased; the quantity in 1878 was 7,301 tons, and in 1882 17,181 tons. The cost of mining and transportation is stated to be $8 a ton, and the mineral sells readily in Montreal at from $17 to $20 a ton. It principally comes from the Ottawa district, which is attracting the attention of capitalists at the present time. The total arrivals in Canada for the year are stated to have been 193,150, of whom 112,458 were *bonâ-fide* settlers for Canada. These figures include 12,862 representing the emigration to British Columbia. The total emigration to Manitoba and the North-West for the year is stated to have been from all parts 70,532, of whom 13,325 were from the United States. It is stated that the emigrants in 1812 had money and property with them exceeding $3,000,000, besides a large amount unascertained taken to Manitoba, which it is impossible to approximate. The number of men arriving in Canada *viâ* United States ports is returned at 12,793.

Journal of the Society of Arts.

No. 1,611. Vol. XXXII.

FRIDAY, OCTOBER 5, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society

CANTOR LECTURES.

THE TRANSMISSION OF ENERGY.

By Prof. Osborne Reynolds, M.A., F.R.S.

Lecture I.—Monday, April 23rd, 1883.

Some few days ago, during a conversation with a friend, I remarked that I was going to give some lectures at the Society of Arts upon the transmission of energy, whereupon my friend inquired, "Is that the transmission of energy by electricity?" To this I replied, "No." The fact is that we have heard so much about electricity that I began to think it was time to recall attention to the fact that there are other means of performing mechanical operations.

I am not sure whether, during the various lectures which have been given in this room on electricity, the actual term, transmission of energy, has been used. But whether it has or not, some of the leading ideas connected with it have been before you.

I think it may be said that the great interest which the public has manifested in the recent advance in the arts relating to electricity has arisen, in a large measure, from the the cry of joy with which Faure's battery was received. "A cry which said, in so many words, here we have at last a means of utilising our waterfalls and natural sources of power" in a way that may relieve us of all the anxiety about our coal fields. To those who had studied the subject, it was evident at the time that this cry was premature. And to some of us, at all events, it seems to be a mistake to encourage false hopes, or, rather, knowingly to base hopes on a false foundation, to hold out as a means of replacing our coal what was, in all probability, only another means of increasing the rate of consumption, for every step in art which facilitates the application of power must increase the demand on the acting sources.

But this is not all; the exaggerated claim set up for electricity, diverted, for a time at all events, attention from the true claim, which would have been sufficient in itself had it not thus been put out of sight. It is not our object at present to save our coal, but to turn it to the best advantage to get the greatest result we can, and if Faure's battery or any subsequent advance in this direction conduces to this, it is no small matter. Now, during the last ten or fifteen years, an entirely new aspect has been given to mechanics by the general recognition of the physical entity which we call energy, in different forms.

We recognise the one thing under different forms in the raised hammer, the bent spring, the compressed air, the moving shot, the charged jar, the hot water in the boiler, and the separate existence of coal, corn, or metals, and oxygen. We see in the revolution of the shafts and the travel of belts in our mills, the passage of water, steam, and air along pipes, the conveyance of coal, corn, and metals, and the electric currents, the transmission of this same thing—energy—from one place to another; and in all mechanical actions we perceive but the change of form of the same thing.

Taking this general or energy point of view, we may get rid of all the complication arising from special purpose, and recognise nothing but the form of energy in its source, the distance it has to be transmitted, and the special form that must be given to it for its application. And this view, although not the best in which to study the special purpose of mechanics or contrivances, is of great importance, inasmuch as it has revealed many general laws, and many fundamental limits to the possibilities of extension in certain directions.

My object in these lectures is to direct your attention to some of the leading mechanical facts and limits revealed by this view.

There is one general remark I would wish to make, by way of caution. I hope nothing I may say will be interpreted by any of my hearers into a prediction as to what may happen in the future. I have to deal with facts, and I shall try to deal with nothing but facts. Many of these facts, or the conclusions

to be immediately drawn from them, may appear to bear on the possibilities—or, rather, the impossibilities—of art. But in the Society of Arts I need not point out that art knows no limit; where one way is found to be closed, it is the function of art to find another. Science teaches us the results that will follow from a known condition of things; but there is always the unknown condition, the future effect of which no science can predict. You must have heard of the statement in 1837, that a steam voyage across the Atlantic was a physical impossibility, which was said to have been made by Dr. Lardner. What Dr. Lardner really stated, according to his own showing, was that such a voyage exceeded the then present limits of steam-power. In this he was within the mark, as any one would be if he were to say now that conversation between England and America exceeded the limit of the power of the telephone. But to use such an argument against a proposed enterprise, is to ignore the development of art to which such an enterprise may lead.

I wish to do nothing of this kind, and if, in following my subject, I have to point out circumstances which limit the possibilities of present art, and even seek to define the limits thus imposed, it is in the hope of concentrating the efforts of art into what may be possible directions, by pointing out the whereabouts of of such barriers as science shows to be impassable.

Although the terms energy and power are in continual, we might almost say familiar, use, such use is seldom in strict accordance with their scientific meaning. In many ways the conception of energy has been rendered popular, but a clear idea of the relation of energy to power is difficult. This arises from the extreme generality of the terms; in any particular case the distinction is easy. I was going to say that it is easiest to express this distinction by an analogy, but, as a matter of fact, everything that seems analogous is really an instance of energy. Power may be considered to be directed energy; and we may liken many forms of energy to an excited mob, while the directed forms are likened to a disciplined army. Energy in the form of heat is in the mob form; while energy in the form of a bent spring, or a raised weight, matter moving in one direction, or of electricity, is in the army form. In the one case we can bring the whole effect to bear in any direction, while in the other case we can only bring a certain portion to bear, depending on its concentration. Out of energy in the mob form we may extract a certain portion, depending on its intensity and surrounding circumstances, and it is only this portion which is available for mechanical operations.

Now energy in what we may call its natural sources has both these forms. All heat is in the mob form, hence all the energy of chemical separation, which can only be developed by combustion, is in the mob form; and this includes the energy stored in the medium of coal. The combustion of 1 lb. of coal yields from ten to twelve million foot-pounds of energy in the mob form of heat; under no circumstances existing at present can all this be directed, nor have we a right, as is often done, to call this the power of coal. What the exact possible power is we do not know, but probably about four-fifths of this, that is to say, from eight to ten million foot-pounds of energy per pound of coal is the extreme limit it can yield under the present conditions of temperature at the earth's surface. But before this energy becomes power, it must be directed. This direction is at present performed by the steam-engine, which is the best instrument art has yet devised, but the efficiency of which is limited by the fact that before the very intense mob energy of the fire is at all directed, it has to be allowed to pass into the less intense mob energy of hot water or steam. The relative intensity of these energies are something like twenty-five to nine. The very first operation of the steam-engine is to diminish the directable portion of the energy of the pound of coal from nine million to three millions. In addition to this there are necessary wastes of directable energy, and a considerable expenditure of already directed energy in the necessary mechanical operations. The result is that, as the limit, in the very highest class engines the pound of coal yields about one and a-half millions of foot-pounds; in what are called "first-class engines," such as the compound engines on steamboats, the pound of coal yields one million, and in the majority of engines, about five or six hundred thousand foot-pounds. These quantities have been largely increased during the last few years; as far as science can predict, they are open to a further increase. In the steam-engine art is limited to its three million foot-pounds per pound of coal; but gas-engines have already made a new departure, and there seems no reason why art should stop short of a large portion of the nine millions.

Other important natural sources of mechanical

powers are energy in an already directed or army form, wind and water power. Here the power needs no development, but merely transmission and adaptation, and hence it has one important advantage over the energy of chemical separation. But there appears to be what are greater drawbacks—in the irregularity of these forces as regards time, and the distribution as regards space. These have both been, and are, good servants to man.

The application of the power of the wind to the propulsion of ships has, doubtless, influenced the economy of the world more than any other mechanical feat; and, not very long ago, water-power played no relatively unimportant part of the work of the world. But it would seem that both these have had their day, and are now relegated to work of a secondary kind, not necessarily so. Some further development of art might bring them to a foremost place again, by developing their use to a hitherto unprecedented extent. Hitherto both wind and water have only had a local application—that is to say, they were used where and when they were wanted. Wind was only used in the sailing of ships on voyages, and for mills, distributed so as to be within range of such corn as was too far from water; while water-power, though very valuable to a certain limited extent, when near habitable country, was otherwise allowed to run to waste; and these wastes included by far the larger sources of this power—the larger rivers and waterfalls, the tidal estuaries, and last, but not least, the waves of the sea, a source which has never been utilised for good. A modern idea is, that it needs nothing but a possible development of art to render these larger sources not only available for power in their immediate neighbourhood, but available to supply power wherever it is wanted, and so displace the coal, or replace the power as coal becomes exhausted. The desirability of such a result fully explains the entertainment of the pleasant idea; but, unfortunately, when we come to look closer into the question, the probability of its accomplishment diminishes rapidly. Many of the considerations of which I shall have to speak bear directly on this question; so that I shall now defer its further consideration, merely pointing out that, to accomplish this result, the power must not only be extracted from the water on the spot and at the same time, but it must be transmitted over hundreds or thousands of miles, and must be stored till it is wanted.

It may well be thought that energy in a directed form, or in the army form, may be better transmitted than in the undirected or mob form. As a matter of fact, however, energy has never been and never can be transmitted as mechanical power in large quantities, over more than trifling distances, say, as a limit, twenty or thirty miles. I say never can, because such transmission depends on the strength of material; and unless there is some other material on the earth of which we know nothing, we know the limit of this. This is a part of my subject into which I shall enter more closely in my second and third lectures.

In depreciating the idea that wind and water will ever largely supply the place of coal, I do not for a moment wish it to be thought that I take a gloomy view of the mechanical future of the earth. This, I believe, admits of immense development, and will not for long depend, as it does at present, on the adjacency of coal-fields. This will be explained as I proceed.

It must not be forgotten that, after all, the most important source of energy is not coal, but corn and vegetable matter. The power developed in the labour of animals exceeds the power derived from all other sources, including coal, in the ratio of, probably, 20 or 30 to 1; so that, after all, if we could find the means of employing such power for the purposes for which coal is specially employed—such as driving our ships, and working our locomotives—an increase of 10 per cent. in the agricultural yield of the earth would supply the place of all the coal burnt in engines. The energy which may be derived from the oxidisation of corn has as yet only been artificially developed in the form of heat, and this may be the only possible way; but physiology has not yet advanced to the point of explaining the physical process of the development of energy consequent on the oxidisation of the blood; and it is at all events an open question whether the energy of corn may not be really a form of directed energy, in which case corn would yield six or eight times as much energy as coal does at present, consumed in our engines. As consumed in animals, it yields a larger proportion of energy—two or three times as much, and may be more—whereas, by burning it in steam-engines, we cannot get half as much. Should we find an artificial means of developing anything like the full directable power of corn—a problem which has not yet been attempted—coal would no longer be necessary for power. I do not mention this as a prediction, but as

showing that there are, besides wind and water, other, and as yet untried, directions from which mechanical energy may be derived in the future.

Electricity is not a natural source of energy, for the simple reason that the metals have mostly been burnt or oxidised during the past history of the earth. But still it is important, at this stage of my lecture, to point out that the energy consequent on the separate existence of metals and oxygen can be developed without combustion, in a totally directed form, *i.e.*, totally available for power.

There are many peculiarities which distinguish the group of elementary substances we call metals, but there is no more distinctive feature than this. This is not a primary source of power, but, as it at present appears, it promises to become the most important secondary source. We cannot find metals existing in a separate form but by the use of power; where and when it exists, we can separate them from the salts, and so store the energy in a form completely available for power. The economical questions relating to such storage of energy will be considered in their place later in the course.

It is not, however, only as effecting storage of power that electricity demands our attention, it also affords a means of transmitting power, which has long held an important place in art, and to which all eyes have been recently turned in expectation of something new and startling.

Before considering the developments of art, and the circumstances on which their further development depend, I shall turn, for a moment, to the processes of nature. The mechanics of the universe, no less than those relating to human art, depend on the transmission of energy. In nature, energy is transmitted in all its forms and under all circumstances, both those which we can imitate in art, and those we cannot.

The most important point with regard to the artificial transmission of energy is the proportion of power spent in effecting the transmission, and the circumstances on which this proportionate loss depends. Is such loss universal? So far as we know, it is attendant in a greater or less degree on all artificial means of transmission, and on all transmissions effected by nature on the surface of the earth. If it were not, this earth would be no place to live upon. No motion would ever cease. As it is, the winds and waters are rapidly brought to rest by the friction which they encounter. Currents of wind and currents of water form the principal means by which energy is transmitted over the surface of the earth. But there are other means which experience less resistance. Oscillatory waves, those of sound, are a very efficient means of transmitting energy. Sounds are not transmitted to an unlimited distance, chiefly because, by the spreading of the wave, the sound becomes weaker and weaker as it proceeds. It is also destroyed by the friction of the solid surface of the earth. Hence the sounds which reach us from bodies high up, as the explosion of a meteor, are heard much further than such sounds made at the surface of the earth, although there are two records of artillery having been heard two hundred miles. Owing to such incidental destruction of sound we cannot say from experience that sound waves in foul air are destroyed, but from the physical properties of gases we know they are.

Waves on the sea are another very efficient means of transmitting power, a means which may be called nature's mill. The waves which take up the energy or power from the wind in mid ocean travel onwards, carrying this energy, and experience such slight resistance that they will, after travelling hundreds or thousands of miles, destroy the shores on which they expend the last of their energy. If we could find a means of utilising the energy of waves, we should not only save our coal, but also save our country from the waves; still, water waves experience resistance which we can better estimate theoretically than practically.

These are the principal ways in which energy is transmitted from one part of the earth to another. There are others, such as earthquakes, but they all show the same thing, that power is spent in the transmission of energy.

If we look away into interstellar space, the case is altered. Here we see two ways in which energy is transmitted—heat, or light, and the motion of the heavenly bodies. In neither of these can we see any direct evidence of resistance or loss of power; and, as judged by any terrestrial measure, there certainly is none. The distance at which we see stars is a sufficient proof of the freedom with which the wave of light travels; while the regularity of the motion of the planetary bodies shows that they encounter no sensible resistance. Yet, although not directly perceivable, there are circumstances that strongly suggest that in both these forms, transmission of energy is

resisted. If space is unlimited, and there are stars throughout it, why do not we see them at greater distances than we do? Under these circumstances, there could be no spot in the heavens at which at a sufficiently great distance there was not a star, so that, if the light were not stopped, the whole heavens would be one fiery envelope as bright as the sun. This is a question which philosophers have not decided. But one, and the favourite way out of the difficulty, is to suppose that the light does encounter resistance, even in interstellar space. This is a subject on which your Chairman of Council has boldly launched; and whether his hypothesis be right or wrong, it has brought to the front a very interesting subject.

With regard to the resistance encountered by the planetary bodies, our evidence is even slighter. A few domesticated comets seem to diminish their speed; and it is not so long since we were all on the *qui vive*, by the promise of the spectacle of an old friend, who seemed to have come earlier than he was expected, on purpose to verify a prediction of plunging into the sun, but instead of doing so he passed away and was pronounced a stranger, to the joy of the nervous, but somewhat to the discomfiture of astronomers.

The energy which we derive from the sun comes to us in the form of sunshine, in a highly directed but extremely scattered form, being uniformly distributed all over the illuminated disc of the earth. It reaches the outer atmosphere nearly in the same condition as it left the sun, having traversed ninety odd millions of miles without any sensible expenditure of power. In the twenty or thirty miles of the lower atmosphere, however, it encounters very great, but variable, resistance. Sometimes half of it, or three-quarters of it, may reach the earth's surface. This is rare in our country, and on the average not more than a very small fraction ever reaches the surface.

When the sun does shine, the sunshine is a form of energy which may be, and is, very largely directed so as to yield power. Any such direction which may be accomplished by human art is undertaken at an enormous disadvantage, on account of the scattered manner in which the energy reaches us. The sunshine must be collected before we can make any mechanical use of it.

In the abstract, there are two methods. The one would be to accumulate the energy of sunshine on a given place, over a long time. This is nature's method. The energy on each portion of the earth's surface, during days, weeks, the whole year, or many years, is accumulated by the growth of vegetables. Corresponding to this, however, art has as yet developed no means whatever. If we don't use the sunshine as it falls, energy is lost for all mechanical purposes. I say if we don't, not that we do use it, but because we can, and have done so in a small way. By means of a lens, or reflectors, the sunshine which falls on a certain place may be concentrated on to a smaller space, and so be sufficient to perform some mechanical operation. In this way, small vapour engines have been worked by sunshine. But the cost of the apparatus necessary for such concentration is out of all proportion to the result accomplished, and shows the art difficulties must be got over by a new departure. There is the further consideration that sunshine on land is too valuable for the maintenance of vital energy to allow of its being devoted to mechanical purposes.

As regards the perfectness of nature's method, so far as I know, no attempts have even been made to test this. It is probably very wasteful, as are all nature's methods, but it is effective. In the first instance, the energy of sunshine is stored on the spot where it falls, in the tissues, but chiefly in the sap of the grass and vegetation. If this is not removed, a large portion of the energy of the year's growth, that which is in the sap, is stored in the seed, and the rest, although apparently again scattered on the decay of the tissues, is to some extent preserved in the ground, and either forwards the next year's crop, or takes the permanent form of peat; and our coal fields are but evidence of the way in which the directable energy of sunshine has been stored under circumstances where there was no immediate purpose for which to apply it. Under present circumstances, however, this energy is almost everywhere too valuable to admit of secular storage.

It is either removed directly by nature's method, the teeth of animals, or allowed to accumulate for a longer period, and then removed by human industry. The further aggregation of this energy involves the transmission of energy in a mechanical sense, and hence involves the expenditure of power. Nature works by means of directly converting this energy into power. The plant accumulates the energy of sunshine, the animal collects and appropriates this energy. This collection is accomplished by

the expenditure of power, which means a re-distribution of that portion of the energy which is capable of direction. The scheme of nature, therefore, is a cycle. The vegetation accumulates the energy, as far as time is concerned, leaving it in a scattered form, requiring power to collect it; this power is in the grass, and only wants direction; this it receives in the animal, which again expends some of the energy in the operation of collecting. If vegetable energy be supplied to the animal in a collected form, then a large portion of the directed energy is available for mechanical purposes. And in this way we may form a rough estimate of the directed energy to be obtained from sunshine in this country. The common agricultural rule is one horse or bullock to two acres, such a horse pulling 120 lbs. at a rate of 3·6 feet per second for eight hours a day. That is a nominal horse.

We thus get something like 3,000,000,000 over and above the energy necessary for the energy spent in eating the corn and moving itself, which we must put down as at least equal in amount. Taking only the available portion, we have the equivalent per acre of nearly three tons of coal burnt in such steam-engines as exist at present. Now the average weight of the vegetable produce from one acre, taking the form of straw and corn, would be about two tons. So that, as far as mechanical power is concerned, coal burnt in our present steam-engines, and corn and straw eaten by horses, yield about the same energy, weight for weight.

The energy which we derive from sunshine is scattered all over the earth, and if it is to be utilised at any spot other than that at which the sunshine falls, it must be transmitted by the expenditure of power.

The energy required for immediate operations of agriculture absorbs a large proportion of the actual energy grown. The surplus is available for purposes of art, and we may say that the primary object of man has been to render this surplus as large as possible. This is accomplished, in the first instance, by applying the residue of energy to so ameliorate the conditions of agriculture as to increase the yield and diminish the labour. In this way the land is levelled, enclosed, and drained; buildings are erected, and finally, but most important of all, roads are made. The effect of roads in increasing the surplus energy is probably greater than any other human accomplishment. The only means of transmitting for purposes of collection or other purpose aggregate energy in the shape of corn, without roads, is on the backs of animals. In this way two or three hundred miles was the absolute limit to the distance an animal could proceed, carrying its own food. On a good road, a horse will draw a ton of food at twenty miles a day, which would mean that it would proceed 800 miles before it had exhausted its supply, or whatever surplus energy there might be available on one spot, half this would be available at 400 miles distance. The labour of maintaining the roads should, of course, be deducted, but this is very small.

The labour of constructing canals is very great, but the result is equal; a horse can move 800 tons twenty miles a day; or a horse could draw its own food for 80,000 miles on a canal. That is to say, with a canal properly formed, a horse could go five times round the world without consuming more energy than was in the boat behind it. Or corn could be sent round the world with a consumption of one-fifth. On railways, at low speeds, the force required is about ten times greater than on a canal, so that the expenditure in going round the world would be about equal to the total energy drawn. If for a moment we replace the horse by the steam-engine, and the corn by coal, we have to add the weight of the engine to the coal, and diminish the efficiency by one-third; we so get that the consumption of coal for the same load of coal as of corn, would be about double, or an engine would go about one-fourth round the world, consuming in coal the net weight in the train, that is exclusive of carriages and engine. Or for every thousand miles corn is carried by rail, something like 10 per cent. of the energy of the corn is expended in draft. This is exclusive of the expenditure in wear and repairs, which will be certainly equal, if not greater. Taking, then, the mean distance by rail between London and the West of America, as 2,000 miles, the present expenditure in the energy of corn in transit is somewhere about 10 per cent. The expenditure of energy on the ocean varies, but if transported by steam it would be probably 10 per cent. more. so that at the present time we are actually receiving available mechanical energy, transported in the form of corn, over 2,000 miles of land and 3,000 miles of sea, entirely by artificially directed power, with an expenditure of less than 50 per cent.; a proportion which 200 years ago would have had to have been spent in transmitting it fifty miles over land; a

result which has been accomplished by the employment in the mean time of the residual energy over and above that necessary for agriculture, together with a further supply drawn from our coal beds.

Turning now our consideration to coal, we find per weight as used at present, this yields rather less power than corn, but not less than two-thirds, and it then appears that coal may be transmitted at the present time, between any two places on the earth which are connected by rail and water, with an expenditure of less than 50 per cent.

In instituting this comparison, the standard has been the actual available power, as developed in our present engines and in horses, with which, weight for weight, there is not much difference. But the adaptability of this energy, so developed for particular purposes, renders the one medium much more valuable than the other. Thus for agricultural purposes, weight for weight, horse food is worth in money ten times as much as coal. This shows the extreme difference in the value of energy according to its adaptability; and the extension, for which there is unlimited scope of the adaptability of steam power, may render it ten times as valuable as at present; nor would this be any small proportion compared with the total energy employed in the work of the world. In this country there are said to be between two and three million horses, and we may put the labouring men down at five millions, or the total power derived from corn down as over three million horses. From the best information going, the work done by steam in this country does not exceed the labour of two million horses, so that more than half the energy is still derived from corn. A greater proportion of the actual corn used for horse food comes across the Atlantic; and for many years maize was sold in this country at an average price of £6 or £7 a ton, the cost of transit being a very small matter. Of course the same cost, say £1 per ton, applied to coal would be a serious matter, considering the low price of the latter. But if, in the present state of our art, energy can be transmitted by corn from any part of the world to this country with an insensible rise, there is no reason to suppose but that, with the advance which science shows us, there is every reason to expect coal may be transmitted with a corresponding small increase in its cost, wherever the demand for it is sufficient ro recompense the outlay necessary for opening the roads or canals.

Miscellaneous.

FISH MONOPOLY.

The following particulars concerning the action of the Society of Arts, more than a century ago, in respect to the supply of fish to London, is taken from Mortimer's Concise Account of the Society, 1763:—

"This extensive undertaking was first proposed to the Society in the month of November, 1761, by John Blake, Esq., who attended the committee to whom it had been referred, to consider of a premium for the catching of turbots by British subjects. Mr. Blake informed the gentlemen of the committee that machines might be contrived, capable of carrying one thousand weight of fish, and at the same time so light, that they might easily be drawn by a pair of horses; and convey the above weight of fish without any injury, from the weather or jolting, to London, from the sea-coasts of the kingdom; he likewise set forth the advantages that would accrue to the nation from the improvement of our fisheries, and particularly that of adding to our marine, by encouraging fishermen to settle on our sea coasts, which by this means would become nurseries for good seamen; for the children, being early accustomed to the watery element, would be the more easily induced, when grown up, to enter into the service of the State. In a word, his whole plan seemed so evidently calculated for the public good, that at the next meeting of the Society, it was resolved to advance Mr. Blake the sum of two thousand pounds to enable him to carry his useful designs into execution, and the said sum was paid to him, without any limitations or particular conditions, and premiums were offered for the best models of machines proper for the undertaking; but it was not till the month of May, 1762, that the scheme took effect, when, proper carriages being made from the model to which the premium had been adjudged, and all other necessaries being duly prepared, these carriages began to travel; and it must not be forgot that, through the indefatigable attention of the manager to everything that might tend to promote the success of this undertaking, an Act of Parliament was obtained, by which the tolls to be paid by these carriages were moderated, the fishermen protected, and the liberty of buying and selling of fish laid open to every person, whether brought up to the trade or not; in a very short time, the public with pleasure beheld a greater variety of fish than had ever been known at London, and several sorts of fish, particularly soles, were brought to market much larger than usual, and in better condition.

"The necessary expenses attending the carrying this beneficial design into execution were so considerable, such as providing a proper number of machines, a place of general reception, stalls for sale,

&c., that Mr. Blake soon found the sum granted by the Society was inadequate to the extensiveness of the plan; but, determined to give all possible satisfaction to this respectable body, he laid before them an account of his expenses, and of the progress he had made, which the Society so highly approved, that they not only returned him thanks for his great care and attention to the trust reposed in him, but likewise on the 19th of May, 1762, agreed, to lend him the sum of one thousand five hundred pounds on his giving proper security, the better to enable him to complete his design, which he has since carried on with great success and amazing intrepidity, surmounting every difficulty that the united efforts of a set of monopolisers of fish in this town could possibly invent to obstruct him in the execution of this great undertaking; and in March last, he once more laid his accounts, unasked, before the Society, at an extraordinary meeting, when his whole proceedings appeared so consistent with his first proposals, and his disinterested zeal and unwearied application in this public service so undeniably evident, that thanks were again returned him, and the gold medal of the Society unanimously voted him, which being confirmed at the next meeting, it was referred to the committee of polite arts to consider of a proper inscription, when the following was agreed to:—'To John Blake, Esq.,' and within the laurel wreath, 'fish monopoly restrained.' Thus, by the benevolent support of this Society, and the public spirit and industry of one of its members, the supplying our markets with fish by land carriage, and the reducing its price, have been happily accomplished; and exclusive of this scheme, the Society annually set apart five hundred pounds, to be distributed in premiums for the encouragement of the turbot fishery by British subjects. So that from these two fertile sources, we may hope to derive two capital national advantages, the employing of a great number of seamen in time of peace, and the forming a considerable nursery of these useful subjects, who may be called forth, by proper encouragement, to the service of their country in time of public danger."

*ON COMPOUND LOCOMOTIVE ENGINES.**

By Francis W. Webb, of Crewe.

In this paper the author describes his method of compounding the locomotive engine. The system differs from that hitherto adopted, particularly as regards the number and disposition of the cylinders. Instead of having one large and one small cylinder, three cylinders are used, viz., two small high pressure cylinders, and one large low pressure cylinder. The two high pressure cylinders are attached to the outside frame plates immediately under the foot-plate, about midway between the leading and middle wheels, and are connected through their piston rods and connecting rods to the trailing wheels. The low pressure cylinder is placed directly over the leading axle, and its connecting rod lays hold of a single throw crank on the axle of the middle pair of wheels. By this arrangement the engine is practically balanced, and enabled to run steadily at high speeds, and, the wheels being driven by separate engines, coupling rods are dispensed with; it is not even necessary that one pair of wheels should be of the same diameter as the other. A passenger engine, constructed on this principle in December, 1881, has run more than 100,000 miles, with the heaviest and quickest trains on the London and North Western Railway, and the commercial results, when compared with ordinary engines doing the same class of work, have been very satisfactory.

* Abstract of a paper read before Section G of the British Association at Southport.

*THE MERSEY RAILWAY.**

By Charles Douglas Fox, M.Inst.C.E.

The question of providing railway communication between Liverpool and Birkenhead is one that has for many years occupied public attention. High level bridges and tunnels have been on more than one occasion proposed, and amongst these the Mersey Railway was authorised, first as a pneumatic, but afterwards as an ordinary railway.

The Company was organised as at present constituted in 1881, with the Right Hon. Henry Cecil Raikes as chairman, the Right Hon. E. Pleydell Bouverie as deputy chairman, Major Isaac and Mr. John Waddell as contractors, and Mr. James Brunlees and the author as engineers.

The length of the railway is 3 miles 8¼ chains, of which almost the whole is either in tunnel or covered way, and it is being constructed for a double line throughout, with stations at Green-lane, Borough-road, and Hamilton-square in Birkenhead, and James-street and Waterloo-place in Liverpool; the works being arranged for trains every five minutes each way, the traffic being expected to be very large.

The land works do not call for special remark, being to a great extent in tunnel through sandstone rock under the public streets.

For the purpose of the works under the river, two shafts have been sunk on each side of the Mersey, one being for pumping purposes, and for communication with the drainage heading hereinafter mentioned, and having a depth of about 180 feet; the other for winding and ventilation from the main tunnel, and about 90 feet deep. These shafts are lined partly with brickwork, and partly with iron tubbing.

From near the bottom of each of the pumping shafts a drainage heading, rising slightly towards the

* Abstract of paper read before Section G of the British Association, at Southport.

centre of the river, to allow the water to run to the pumps, is being driven, partly by hand and partly by Colonel Beaumont's boring machine, which cuts a circular heading seven feet diameter. Out of a total of 1,774 yards, 1,143 yards have already been driven, up to September 5, 1883.

The sandstone rock through which the works are carried, though hard and compact, is porous, and yields more or less water. The pumping machinery on each side consists of two 20″ and two 30″ sets of bucket lift pumps, driven by compound engines by Hathorn Davey and Co., of Leeds. A 40″ set of plunger pumps, to be driven by an overhead engine by Messrs. Barclay and Son, of Kilmarnock, is now being fixed as a duplicate on each side. The 30″ sets have hitherto been found amply sufficient to clear the works.

The paper, which was illustrated by diagrams and models, describes the mode of setting out the works, the precautions adopted under the river, the means used for tubbing back the water, and the details of the main tunnel, the excavation for which has now progressed some 1,590 yards, closely followed by the brickwork lining.

IRON INDUSTRY OF HUNGARY.

It appears from a report recently issued by Her Majesty's Secretary of Legation at Buda-Pesth, that the progress of the iron manufacture in Hungary has been greatly retarded by the want of suitable fuel, and, at the present time, though inferior kinds of fuel are used with advantage, yet the absence of a better description is still a great drawback to the production of iron in this country. Vegetable fuel is of necessity used by the largest iron works of the country, and of forty-eight works with fifty-six blast furnaces, only four used either coke or coal, the remainder using charcoal. Ironstone deposits are, as regards their quality, variety, and extent, at least not behind those of the neighbouring countries. Spathic iron is found in several districts, and especially in Gömör, Szepes, Abany, Toma, Zólom, Liptai, and Szörény. The "ore mountain" of Dobschau, with its numerous deposits, running, in some places, to a thickness of thirty-six yards, yields ores mainly worked in the open, which contain from 2 to 4 per cent. of spathic iron of great purity and value. Of late years much importance has been attached to the spathic and brown ore deposits of the Zipser districts, especially in the vicinity of Vöröspatak, owing to the export trade with Upper Silesia. Of still greater importance are the mines in the Hunyad district, containing extensive deposits of brown ore merging into red. These deposits extend, with partial interruptions, over an area of more than nineteen miles. The future of the Hungarian iron manufacture depends on the production of superior iron, as the cost of production is materially increased by the daily growing necessity of bringing the iron from greater distances. A very large annual export of iron ore now takes place from Upper Hungary, the amount averaging over 125,000 tons. Notwithstanding that the forests in the immediate vicinity of the iron works are much reduced, and in some cases entirely exhausted, yet there is still an abundance of wood and charcoal in Hungary. It is estimated that the extent of forest land considerably exceeds 6,175,000 acres. The annual growth of timber in the forests is 14,000,000 cubic feet, which could produce—if only a third of this amount were used—over 500,000 tons of charcoal pig iron annually. The forest lands are, however, in almost impenetrable mountain districts, and at a great distance from every means of transport, thus making them practically unavailable for manufacturing purposes. The management of the iron works is now almost entirely in the hands of technically educated and practically skilled men, and the results are very satisfactory; for example, the works of the Salgo-Tarjan-Rima-Murany Company produce 200 lbs. of pig iron with not more than eleven bushels of beech charcoal. The Royal Works of Goresdia Hunyad use rather more than twelve bushels of charcoal for every 200 lbs. of pig iron, and the other works use about the same proportion. The production of these smelting works varies per blast furnace from 300 tons to 520 tons per month, according to dimensions of furnace and description of iron made. At the present time Hungary possesses an aggregate of forty-one pig iron works, and fifty-two blast furnaces in operation. The yearly production of the whole country amounts to 167,500 tons, of which 17,600 tons take the form of castings.

MARSEILLES INTERNATIONAL EXHIBITION.

Almost concurrently with the Nice Exhibition of the coming winter, a maritime exhibition, the first of a series, is announced to be held in the Palais de l'Industrie, Marseilles, from the 15th November, to the 30th April. Products, specimens, machines, models, and drawings may be exhibited, and the following is an abstract of the classification:—

I. Navigation—models and specimens of vessels, engines and appliances, armament.

II. Furniture, clothes, hygiene.

III. Cereals and other products, preserved food and beverages.

IV. Harbours, lighthouses, maritime establishments, packing and *manutention* (the handling and delivery of goods).

V. Life-saving appliances.

VI. Natural or manufactured products in use on board ship; mineral and metallurgical industries; the chemical arts.

VII. Produce of waters, alimentary and non-alimentary, and their preparation.

VIII. Tackle, and methods of fishing and hunting.

IX. Application of science to navigation.

The following are the principal regulations:—Ground space will be charged 25 fr. (£1), and wall space 10 fr. (8s.) per square metre (10¾ square feet); books, pamphlets, and maps will be subject to a tax of 5 fr. (4s.) each. A strong floor will be laid by the management free of charge, who will undertake the erection of show cases for exhibitors. Exhibits may be sold, but not removed till the close of the Exhibition. Public trials of apparatus will be made, and conferences and lectures arranged during the time the Exhibition remains open. Application for space must be made to M. Lorgeas, Palais de l'Industrie, Rue Noailles, Marseilles, and goods must be sent before the 31st of October.

BEE-KEEPING IN INDIA.

In September, 1881, Mr. John C. Douglas, of the Indian Government Telegraph Department, addressed the Secretary of State for India with a view to the introduction of bee-keeping into India. He pointed out that, as far as his inquiries went, the natives of India take honey and wax from wild bees only, and he expressed the opinion that "as sweets form so important a constituent of the native dietary, there would be ample demand for honey for domestic consumption," and that "the climate is favourable to successful bee-keeping, and some of the plants extensively cultivated (*e.g.*, mustard) would yield honey in abundance." He further asked for any information which the Government might possess relating to past efforts in the same directions. Sir Louis Mallet answered that no information relating to the domestication of the Indian honey-bee had been received at the India-office. In November, the Secretary of State forwarded the correspondence to the Government of India, with the remark that the subject appeared to him to be of sufficient practical interest to engage attention. Sir George Birdwood contributed a memorandum, in which he said, "The subject is of great interest, and likely to prove of no little importance, if once seriously taken up in India. The bee has been more completely domesticated in India than in any other country, but only in the Himalayan regions; and in all the rest of India, the natives, as Mr. Douglas observes, take honey and wax from wild bees only, simply, I fancy, because cane sugar is so abundant." Sir George then referred to Moorcroft's account of the management of bees in Cashmere, and added:—"The bees in Western India, I may add, produce excellent honey, but the combs are practically inaccessible. Nothing, however, would be easier than to induce the bees of Western India—and, it may be presumed, of India generally—to yield their honey within reach, either by the European or the Cashmerian methods of hiving them. In Ceylon also, according to Sir Samuel Baker, the bees are all wild." Mr. Douglas sent the following questions, which were issued with the rest of the correspondence by the Government of India, to the various local Governments and administrations:—

"*A.* What quantity of honey is produced in India, and how is it disposed of? What price is realised on that sold or exported, and how is the remainder consumed? Is there any demand for honey, and is any imported?

"*B.* Are bees domesticated in any part of India, and is there any information available of the habits, yield, habitat, mode of harvesting, &c., of the wild bees? Probably the Forest Department would give valuable information.

"*C.* What are the varieties of bees indigenous to India likely to prove valuable if domesticated? Do they resemble the black, Italian, or other European variety, and how are the habits of the insect altered by the climate of the plains of India as compared with the habits of bees of colder climates?"

A large number of reports in reply from forest and district officers, and other persons who have paid attention to the subject, were received by the Indian Government, and these have been published in an official pamphlet.*

The following broad conclusions are drawn from the information thus received:—1. That several varieties of honey-bees are found in every province of India where there is sufficient forest or jungle, and that the honey of some of the varieties is good and in considerable demand. 2. That efforts have been successfully made in the hills by Europeans to domesticate Indian bees, but that bee culture is only practised by natives in the very rudest way. 3. That it is very doubtful whether the bee could be domesticated in the plains, owing to the dearth of flowers during the three or four months preceding the rains. 4. That in Southern India, persons (Mr. Stormont, of Bombay, and others) have given up all attempts to domesticate the most common variety of bee found there, on account of its intractable nature. The Government of India arrived at the conclusion that "the industry is unlikely ever to be of great importance in India. It can only be followed in the hills, where flowers abound throughout the greater part of the year, or in the forests where food is equally plentiful. In the populous country of the plains, bee-keeping, as a general industry, seems impracticable." Opportunity will, however, be taken of the Calcutta International Exhibition to make some further inquiries on the subject.

The Rev. T. Mayer, of Bannu (Punjab), mentions five kinds of Indian bees. No. 1, the commonest and wildest, is a small black bee with (in the workers) a patch of orange on the anterior part of the abdomen; it builds one comb on the branch of a tree, and has

* A Collection of Papers on Bee-keeping in India. Calcutta, 1883.

a very venomous sting, but this is compensated for by the delicious purity and flavour of the honey. No. 2 is like the English bee, only a little more yellow; it is rare, and builds in hollow trees. No. 3, from Waziri land (Makin), is very large; but No. 4, seen about Lucknow and Delhi, inside high arched gateways, is probably the largest bee in the world, and its comb contains over a hundredweight of honey. No. 5 is described by the natives as living in the ground. The lizards, frogs, tarantulas, and chocolate and yellow hornets are deadly enemies to the bees; ants also are troublesome, notably the large black ant and the white ant.

There are, it is believed, six sorts of bees in Southern India, but none of them have been domesticated. The honey and wax is sold in petty bazaars, and locally consumed. The largest species make their combs on rocks, where they are taken by the wild tribes by the aid of smoke, and ladders made of creepers, &c. These bees are dangerous, and have killed men and horses; but others which build in boughs, in eaves of houses, and in the trunks of trees, are inoffensive.

There are nine kinds of bees in Burma, of which five only are honey-producing. The largest bee is the *Pyagyee*, which measures over half-an-inch in length; it has yellow sides, and dark back, with yellowish-brown wings, and stings when disturbed. It places its hive under large horizontal branches of trees. These hives are three to six inches wide, and nine to eighteen inches long, often extending two feet on the branch.

Mr. W. Hill reports that a light black bee, with light grey wings, about the size of the common English fly, is domesticated by villagers in several parts of Coorg. The quantity of honey produced in Coorg may be roughly estimated at 25,000 lbs., of which 14,000 lbs. is from domesticated, and 11,000 lbs. from wild bees. The price realised for the former averages three annas the pound, and for the latter, which is of inferior quality, two annas the pound. The wild bees are most valued for the wax which they produce. The price of the best wax is eight annas eight pie the pound, and that of the ordinary quality, five annas nine pie the pound. Mr. Carroll, Forest Ranger in charge of South Canara Forests (Madras), reports that the quantity of honey produced in those forests average about 60 maunds annually, and from 80 to 100 maunds once in ten years, when the *coorgi* plant is in blossom. The selling price within the district varies from two to three and a-half rupees per maund, while the price of that exported is from four to five rupees per maund. The Deputy Conservator of Forests, Arakan, British Burma, in describing the enemies of the bee, says that man is its chief enemy. Whenever a villager happens to stumble upon a hive in the jungle, he proceeds to appropriate its contents as soon as convenient. The only exception is made in the case of the species which does not yield honey during the rains. The *pyagyee*, however, yielding most honey and wax, has no natural close time, and no protection whatever, except its sting. Its large hive on the branches of trees is more readily remarked than are the abodes of the species who settle in the hollows of trees, posts, &c. The *pyagyee* yields from half a seer of honey per hive to twelve seers (765 tolas) in exceptional cases. The pot of twelve seers is sold for three rupees. In the twenty-four Pergunnahs (Bengal) honey is collected in considerable quantities from the Sunderbunds, but no statistics are kept. Roughly speaking, the annual yield is put down at about 13,000 maunds, or 1,040,000 lbs. Bees are not domesticated anywhere in the twenty-four Pergunnahs, and honey and wax are gathered from wild bees in the jungles. It is said that wild honey is produced in such abundance in the Sunderbunds that the domestication of bees would scarcely pay. In the Darjeeling district (Bengal) bees are half domesticated. Mr. E. P. Durnford writes:—"The bees are usually started by a queen (or as they call her 'the Rajah'), accompanied by her bees, coming voluntarily to a house, and swarming on, or close by, the house. She is easily recognised, owing to the loud noise which she makes. She is usually, together with the bees, enticed into a box, or hollow trunk cut into two pieces and made into a box, which is then placed near her swarm; if necessary, a little honey is smeared on the box and round the hole, which is, of course, left in it."

These few references to the contents of the various reports on the subject of bee-keeping throughout India will be sufficient to show how much information is contained in this important collection of papers published by the Government of India.

Notes on Books.

PAPERS OF THE CONFERENCES HELD IN CONNECTION WITH THE GREAT INTERNATIONAL FISHERIES EXHIBITION. London: William Clowes and Sons.

The published series of papers read at the Conferences has now extended to a considerable length, and most of the questions relating to fisheries will be found treated in one or other of these pamphlets. Professor Ray Lankester deals with the "Scientific Results of the Exhibition," and expresses the hope that the chief scientific result will be the formation of a "National Laboratory of Marine Zoology." Mr. C. E. Fryer advocates the establishment of a "National Fisheries Society," and Mr. Shaw Lefevre, M.P., and Lieut-Colonel Garcia Solá, both deal with the question of fishery legislation. Prof. Leone Levi treats of the "Economic Condition of Fishermen," Mr. R. H. Scott of "Storm Warnings." Mr. D. Howitz of "Forest Protection and Tree

Culture on Water Frontages," and Mr. Massey Mainwaring of the "Preservation of Fish Life in Rivers by the Exclusion of Town Sewage." The "Fisheries of Canada" are described by Mr. L. Z. Joncas, and the "Fishery Industries of the United States" by Mr. Brown Goode. Papers on the "Food of Fishes," "Coarse Fish Culture," and "Fish Transport and Fish Markets" are contributed by Dr. Francis Day, Mr. R. B. Marston, and Mr. Spencer Walpole, respectively. Of special fisheries, Mr. Alfred W. Ansell treats of "Trawling;" Mr. C. M. Mundahl of "Line Fishing;" Mr. T. Cornish of "Mackerel and Pilchard Fisheries;" Mr. R. W. Duff of the "Herring Fisheries of Scotland;" Capt. Temple of "Seal Fisheries;" Professor Hubrecht of "Oyster Culture and Oyster Fisheries in the Netherlands;" Mr. Saville Kent of "Artificial Culture of Lobsters;" Mr. Cornish of "Crustaceans;" and Mr. Harding of "Mullusks, Mussels, Whelks, &c., used for Food or Bait." "Fish Diseases" is the title of Professor Huxley's paper, but he explains that he has confined his attention to those of the salmon. Dr. Cobbold's subject is the "Destruction of Fish by Internal Parasites;" and Sir Henry Thompson's "Fish as Food."

Handbooks Issued in Connection with the Great International Fisheries. London: Wm. Clowes and Sons.

Mr. Spencer Walpole, in his pamphlet on the "British Fish Trade," deals fully with its present condition, and sums up by saying that the three points in which the action of the State may properly be employed in promoting the fishing industry are:—(1) The preparation of adequate statistics; (2) the provision of proper police regulations for order at sea; and (3) the facilitating the construction of adequate fishing harbours. Mr. J. C. Bertram, in his "Unappreciated Fisher Folk," gives chapters on the Scotch herring fishers, the fishers of Yarmouth, the Cornwall pilchard catchers; the trawlers and the cod-men of the North Sea; the Irish and foreign fisher folk. Dr. Day has contributed two handbooks to the series, one on "Fish Culture," and the other on "Indian Fish and Fishing;" Mr. Fryer gives a history of the "Salmon Fisheries;" Mr. Wm. Adams relates many things of "Fisheries and Fishermen of all Countries;" and Mr. Henry Lee has entitled his remarks upon the kraken and the sea-serpent, "Sea Monsters Unmasked."

A Graduated Course of Instruction in Linear Perspective, specially adapted for Students preparing for the Senior Grade Examination of the Science and Art Department. By David Forsyth, M.A. Glasgow: James Maclehose and Sons.

The object of this book, which is the result of many years' teaching, is to present the elementary principles of perspective to students clearly, and without unnecessary mathematical details. A series of test papers, intended to estimate the progress of pupils, is added.

Oliver Madox Brown: A Biographical Sketch, 1855–1874. By John H. Ingram. London: Elliot Stock. 1883.

Oliver Madox Brown, the son of Mr. Ford Madox Brown, the famous artist, died in 1874, at the early age of nineteen, full of promise. It was said by a friend that "no memoir will ever do Oliver justice;" but the author of this sketch has endeavoured to write a faithful record, that shall give the world some idea of one from whom his friends expected so much. The book is largely taken up by letters of the subject, and an analysis of the stories written by him.

The Hygiene of Armies in the Field. By Robert Rawlinson, C.B. London: Wyman and Sons.

This is a paper which Sir Robert Rawlinson read at the Parkes Museum in June last. The author relates his own experience as Engineer Member of the Sanitary Commission sent out to the Army in the Crimea in the spring of 1855, and also refers to the sanitary incidents of the late war in Egypt. He points out what must be done to put an Army in a proper sanitary condition, and to continue it in that state in spite of the great difficulties of the position.

General Notes.

Philadelphia Electrical Exhibition.—An International Electrical Exhibition, under the auspices of the Franklin Institute, will be opened at Philadelphia, on Tuesday, September 2nd, 1884. An Act has been passed by Congress, which provides for the admission into the United States, duty free, of all articles for exhibition only.

Syrian Silk.—The *Central Blatt für Textil Industrie* gives some details as to a vegetable substance somewhat resembling silk, to which attention has lately been drawn by its having been exhibited in Greece. It is stated that this substance is a silky-haired portion of a tree-like shrub which comes originally from America, but is found in Syria and the South of Europe (*Asclepias Syriæ*), of the family of the Asclepiades. It is also known as the Syrian silk-plant. The substance in question is used for stuffing very soft cushions, when mixed with silk and wool. This Syrian silk is used in different tissues. The milky juice of the plant is said to be poisonous, and the tough stalks can be used in the same manner as the corresponding portions of the hemp plant.

Journal of the Society of Arts.

No. 1,612. Vol. XXXII.

FRIDAY, OCTOBER 12, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PREMIUMS FOR THE 129th SESSION.

The following Prizes are offered by the Council for the year 1883 :—

John Stock Prize.—A Society's Gold Medal, or £20, for the best design from a poem, or from history, or from the Scriptures, prepared with a view to Mural Decoration.

Benjamin Shaw Prize.—1. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the operations of coal-mining." 2. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the manufacture, storage, and transport of explosives."

The Council leave it to the competitors to bring the plans under their notice in any way they may think proper, whether by model, written description, or otherwise.

Howard Prize.—A prize of £100 for the best Essay on the Utilisation of Electricity for Motive Power. Preference will be given to that Essay which, besides setting forth the theory of the subject, contains records with detailed results of actual working or experiment. The Society reserves the right of publishing the Prize Essay.

Fothergill Prize.—A Society's Gold Medal, or £20, is now offered for the best Invention having for its object the Prevention or Extinction of Fires in Theatres, or other places of public amusement.

Mulready Prize.—A Society's Gold Medal, "to that student in a School of Art in the United Kingdom who exhibits the best Drawing from the nude figure, executed in black and red chalk, in the manner so successfully practised by Mulready."

Designs, plans, models, essays, descriptions, inventions, &c., intended to compete for any of the above Prizes, must be sent in on or before the 31st October, 1883, to the Secretary of the Society of Arts, John-street, Adelphi, London.

Further particulars relating to the Prizes may be obtained on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

THE TRANSMISSION OF ENERGY.

By Prof. Osborne Reynolds, M.A., F.R.S.

Lecture II.—Monday, April 30th, 1883.

In my last lecture I dealt with the transmission of energy through the means of coal and corn, showing that by either of these means power may be transmitted by rail, with an expenditure of 1-12,000th per mile, or by water of 1-120,000th per mile, this either through the agency of horse or steam.

This ease of transmission, however, depends entirely on the railroad or water, and is only possible between places so connected. Hence such means are only applicable to what may be called the mains of power.

We come to-day to consider other means of transmitting energy in smaller quantities applicable to its distribution for immediate application. Such transmission is not a matter of secondary importance, although the distances over which it is transmitted may be comparatively insignificant. To emphasise this, I may recall what was previously mentioned, namely, that the relative price of corn and coal shows that the power given out by horses is at least ten times as valuable as that of steam, for more than half the purposes for which energy is used; or that it answers better to burn our coal in bringing corn from America to plough in England, than to use the coal here for ploughing.

In fact, for most of the detailed purposes for which power is used, to draw it from a large source (such as a steam-engine), distribute it and adapt it to its purpose, is ten or twenty times more costly than its transportation in large quantities over thousands of miles.

Now the means of artificially transmitting power may be considered as three. The power may be stored in matter in various ways, and the matter with the energy transported—as, for instance, in our watch springs. The second means is the transmission of power by moving matter, without actually storing the power in the matter—as in shafts and belts, hydraulic connection, &c. And the third method, which is distinct from the others, is the transmission of energy, in the form of heat or electricity, by the flow of currents through conductors; in this way all the power in the steam passes through the boiler-plates from the furnace into the boiler. Of course, each one of these means includes an infinite variety of detailed contrivances, more or less dissimilar. But there is good reason for classing them under these three heads, for all the contrivances under each of these heads are subject to the same general limits, whether those of efficiency or distance.

There is one thing in common to all these means of transmission, and that is that they all involve a material medium. The quantity of matter required constitutes a primary consideration in all of them. This quantity of matter is fixed by what we may call the properties of matter, one of the most important of which, as regards the first two means, is the possible strength of material. Looking round, we see the effect of the limited strength of material in all nature's works. Of course it may be that we shall be able to work with stronger materials than we have at present. Organic materials, such as the feathers and tissues of animals, are stronger than steel, weight for weight, so that there is a possibility of improvement, but that man will go beyond nature in constructing organic fibre seems improbable, and such possibility of improvement as exists may be discounted. At present we may set down our strongest working material as steel, the art of working in which is so perfect, that we may calculate on nearly the greatest strength for all purposes. I have taken fifteen tons on the square inch as the limit of safe working tension, in making the estimates which I shall now bring before you. First of all, I will ask your attention to the possibilities of transporting power in a stored form.

The question of economy in the conveyance of energy in a stored form is simply one of the intensity with which it can be stored. If we want to carry energy about, we must have it stored in some material form—and this material has to be carried by ordinary means—so that the question of economy is simply the amount of available energy that we can store in a given amount of material.

If energy, stored in a particular manner, is more readily available for some special purpose than that stored in another, then it may, on the whole, be more economical to carry it in that form. This is abundantly illustrated in our watch springs.

The greatest amount of energy that can be stored in a given weight of steel is very small, compared with other means. To take a familiar unit, to store the energy necessary to maintain one horse-power for one hour would require no less than fifty tons of steel—that is to say, fifty tons of steel in the form of watch springs, all fresh wound-up, would not supply one horse-power for one hour; and yet this is the commonest form in which energy is carried about.

It is the adaptability of the spring, and the readiness with which energy can be put in and taken out, which recommend the steel spring.

India-rubber will store much more energy than the same weight of any other material, say, eight or ten times as much as steel; but with this, several tons would be required to store the horse-power for one hour. A much more capacious reservoir, according to its weight, is compressed air. There are certain difficulties in getting the energy in and out without loss; but with air, compressed to four times the pressure of the atmosphere, we should only require about 20 lbs. of air to yield the amount of one horse-power for one hour. Of course, if we were going to carry this air about, to the weight of the air would have to be added the weight of a case to contain it, and such a case, in the form of steel tubes, would weigh something like 230 lbs.; so that, in any form in which we can carry compressed air about, we shall have about 300 lbs. to carry for each horse-power per hour.

Another means of storing energy, very largely used, is hot water. This is largely used in a way not always recognised. The boiler serves another purpose besides that of converting the energy of the furnace into the power of the steam. It stores the power, and equalises the stream between the fire and the engine, a function the importance of which has been brought to the front in the recent efforts to apply electricity for communication of power, where the want of a similar reservoir between the generator and the motor has, in many cases, proved fatal to the enterprise, a want

which secondary batteries are now being used to meet. Hot water has also been employed as an independent reservoir, and as such it is better in some respects than compressed air. The fundamental limits are of much the same kind. In this case, however, the absolute limit is temperature. The vessel in which the water is carried must be strong enough to withstand the pressure, and all materials lose their strength as they get hot. The considerations are here much the same as in the steam-engine, and 400° Fahr. appears to be about the limit. At this temperature, for every 4 lbs. of water the cases would weigh 1 lb., and there would be no advantage of large over small cases; except as a matter of construction, the proportionate weight would be the same. The gross power of a pound of water, the steam being used without condensation, is about 20,000 foot-pounds, or we should require 50 lbs. to store 1,000,000; this is the extreme limit again. The present accomplishment would be about 150 lbs. per 1,000,000 foot-pounds stored—rather less than compressed air. The only other means of packing power, that is at present looked to, is that of the much talked about secondary battery. Here there is a great deal of doubt as to what is actually accomplished; take the most reliable statements, from which it seems that in order to get 1,000,000, something like 100 lbs. of battery is required, which will make this means of storing energy very much the same as compressed air or hot water.

It is important to notice that the initial cost of the energy stored by these means differs considerably. This cost is rather difficult to estimate; but a practical estimate may be formed in this way:—

Taking the power, as delivered by the steam-engine, as 1, how much of this power will be given out after secondary storage? Here the hot water has an advantage, for it is heated directly by the coal, and is all on its way to the steam-engine.

With compressed air, there are three operations, each as costly as the steam-engine, and at least half the initial power is spent during the compression, storage, and expansion; so that the energy is at least double as costly in coal, and six times as costly in machinery. I have put it down as three times as costly as the energy in hot water, but this is considerably below the mark. The electricity has also to go through three operations, and cannot be less costly than compressed air.

Now, if we revert for one moment to the consideration of the main transmission of power, we see at what an immense disadvantage any form of packed energy is, compared with coal or corn; as at present packed it weighs at least 100 times as much.

While the limits imposed by the strength of material render it certain, as far as compressed air and hot water are concerned, that the weight can never be reduced by more than half, these limits are sufficient to show that packed energy cannot be transported over long distances, even if it can be obtained directly from such falls as Niagara. But this is no argument against the importance of these means for short distances and special purposes. As I have already pointed out, our watches show that circumstances may render the very heaviest means the best for particular purposes. And if in any of its forms packed energy were directly available for household purposes, though it cost ten or twenty times as much as power direct from the steam-engine, its use would still be assured.

One fact should be noticed, that in all these forms the power is packed, and needs nothing but drawing off, whereas corn or coal do not contain the power. The oxygen is an equally essential ingredient. In this fact lies the great advantage of corn and coal for transportation. They are really, so to speak, but cheques for power, which can be cashed at any spot where a bank, in the form of a steam-engine or a horse, exists. But, of course, not being energy, they are not generally current—in fact they are worthless, except where the bank exists, and where they represent such small amounts that the banks refuse them. Now these forms of packed power are, so to speak, generally current that is to say, they are available under almost all circumstances, and in greater or less degrees of smallness; from the very smallest, which is the watch spring in our pockets, which supplies a continuous stream of power in less than one ten thousand millionth of a horse-power; or the Whitehead torpedo, which carries some million foot-pounds of energy under the sea. Perhaps the most pressing purpose for which these forms of packed energy are wanting is that of locomotion.

The distance which a locomotive body, be it animal or machine, can travel, loaded or free, is limited by the ratio of the power which it carries to its gross weight. The speed which it can attain is limited by the rate at which it can use its energy com-

pared with its weight. Hence there are two particulars in which we can compare the different forms of stored energy for locomotive purposes.

Let us take the horse and the locomotive. A full-sized horse weighs, say, 1,500 lbs., and, at a rate of 2½ miles an hour, will go five hours without food, doing about 10,000,000 foot-pounds of work, including the work necessary to move itself; this represents the largest result, or about 150 lbs. per 1,000,000 foot-pounds. If the horse is put to ten miles an hour, it will not do more than 1·5 million foot-pounds in a single journey, besides moving itself. Probably the greatest rate at which a horse can use its energy is about 4,000,000 foot-pounds per hour, or 750 lbs. per horse-power.

A locomotive with its tender, say, weighing sixty tons, exerts 500 horse-power gross—270 lbs. per horse-power per hour; so that a first-class locomotive with tender is above one-fifth as heavy for its power as the horse; but then the horse cannot go more than ten miles an hour.

Now, in a general way, passenger locomotives carry coal and water for eighty or one hundred miles, *i.e.*, two hours; or the locomotive already mentioned expends at one run about 2,000,000,000 foot-pounds; which means that the gross weight of the locomotive is about 60 lbs. or 70 lbs. per 1,000,000 foot-pounds of power with which the locomotive starts.

In thus taking the gross weight of the horse or locomotive, we must remember that this includes the weight of carriage and machinery, and that in whatever form the energy is carried, this weight must be added. In the locomotive the weight of water and coal in the tender for two hours' journey weighs about one-quarter the gross load; and if we add the weight of the boiler, we may consider the carriage and machinery at one-half to one-third the gross load. Taking the latter, and substituting for the boiler, coal, and water, energy in either of the above forms, the coal, water, and boiler would be about 40 lbs. per 1,000,000: so that, if we took compressed air instead, we should have one-fourth the power; or the engine would run for thirty minutes instead of two hours, a distance of twenty-five miles instead of a hundred. A fireless locomotive might do more than this, say, thirty-five minutes, or thirty miles, at the same speed as the locomotive. Faure's battery, if it could be made to work at all, would carry the locomotive forty-eight minutes, or thirty-five to forty miles.

These figures seem to show that the locomotive has little to fear from any of these rivals, that is under circumstances where the smoke and steam are no harm, and where a full-sized locomotive is required. But there are already some cases where the locomotive is required and where the burning of coal is impossible. Should the Channel Tunnel be made, there will be a great field for some form of packed energy; but it does not seem that the promoters have much faith in a smokeless means of working the tunnel being forthcoming. As regards horses, however, there is nothing to show why the horse should not be rivalled by some one of the forms of packed energy. There have been inventors who have constructed carriages to go by clockwork. This has now become possible, substituting hot water, compressed air, or a battery for the spring, and such means have already rivalled the horse on tramways. The fact that horses are at all used for tramcars is a matter of as much surprise as that steam should be used on underground railways. For locomotives driven by compressed air might certainly be made cheaper and better in every way.

At the present time it would probably answer well, in a pecuniary point of view, to supply in compressed air energy at the rate of 2d. or 3d. per million foot-pounds, provided a sufficient quantity could be required; so that if simple and efficient means of applying such energy to perform the heavier part of manual labour, we might get as much power for 6d. as what a man will do in a day at 2s. But it is the means of applying it that is wanting.

Even for horse work—except where there is a railway or tramway—the mechanical means are wanting. We have no mechanical substitute for the horse's foot. So that although there are more than a million horses in this country continually engaged in the operations of husbandry, where they work in groups so as to get three or four horse-power at one operation, an amount of power not too small for the direct application of steam power; and although for twenty-five years steam-engine makers have been doing their very best to adapt the power of the steam-engine to this labour, which exceeds any other actual application of power, the possibility of steam ploughing with economy is still a question. The use of steam on paved or on macadam roads is much the same, so that, until steam has been applied to

such purposes, there is little hope for other forms of stored energy.

Coming back for a moment to Faure's battery, I would carefully point out that the result which I have put down—100 lbs. per 1,000,000 foot-pounds of energy—refers to what has been already accomplished, and not to any possible limit. The principles involved in the chemical action of these batteries, in fact in all batteries, are well understood; and so far as these principles are involved, it is easy to define limits; but there are a number of secondary actions which are not so well understood, and which have hitherto prevented any approach to the theoretical limits. In the Faure's battery, the theoretical limits are about 3 lbs. per 1,000,000 foot-pounds. That is to say, the oxidisation of 1 lb. of lead to litharge, and the deoxidisation of 1 lb. of peroxide, together, yield 360,000 foot-pounds. How far, at present, Faure's battery is within this limit, at once appears something like twenty-four times. Should this be accomplished, power could be packed at the rate of 1,000,000 foot-pounds for 3 lbs., or say 6 lbs. weight, to allow for wastes, a result which would most certainly displace steam in the locomotive, but which would still leave coal and corn six times the lightest vehicle of power.

It should be noticed, however, that although the means of doing so are still entirely wanting, could other metals, such as iron or zinc, be used instead of lead, the results would be much greater. This is shown by the relative amount of power necessary to oxidise or deoxidise these materials, which we see for iron and zinc are five or six times greater than for lead; here is an apparent opportunity for art.

Should this be realised, then, indeed, coal might be displaced as the cheapest medium for the transmission of power, but that would be a small matter compared with the change that would occur in our ways of applying power. For the dream of Jules Verne, of 20,000 miles under the sea, would become a reality, and, instead of steamboats, we should travel in submarine monsters as yet unnamed, which we may call steam-fish.

But if science as yet imposes no limits beyond those I have mentioned, at the same time it holds out no prospect. The chemistry of these batteries has been very deeply considered, and those who have studied the subject most deeply apparently see no direction in which to direct their efforts; so that any great advance in this art must entail a great discovery in science.

There now only remains for me to consider the transmission of power as power, or by electricity, a most important branch of my subject, which I must take in my next lecture.

Miscellaneous.

JOHN HILL'S PENNY POST.

In the last Report of the Postmaster-General, an historical summary of the government of the Post-office is reprinted from the first Annual Report, 1855, but no note is there taken of a proposal made in the middle of the seventeenth century, by a namesake of Sir Rowland Hill, to establish a penny postage. The title of the pamphlet in which John Hill expounded his views is as follows:—"A Penny Post: or a Vindication of the Liberty and Birthright of every Englishman, in carrying Merchants and other Men's Letters, against any restraints of Farmers of such employments. London, 1659." It will be seen that the main point of the author's contention related to the Government's monopoly. He writes, under the heading of "Some amongst many other reasons that might be given against the letting of carriage of letters to farm:"—"The statute of 21 Jac. provides, That all commissions, grants, licenses, and patents granted, or to be granted, for working or using any thing or of any other monopolies, shall be utterly void, and the wisdom and care of that Parliament in preserving the people's rights against any monopolizing restraints in their lawful employments is observable, the penalty being trebble damages and double costs to the party grieved, and it must certainly be an offence against the common law when it is so deeply against the common reason, correspondency being absolutely necessary in relation to commerce; it's most unjust and unreasonable that a man be compelled to employ a man in carriage of his letters and commodities, whom perhaps he had found unfaithful (rather than another in whom he doth confide), and that a man be compelled rather to employ a man that intends to introduce monopolies to the prejudice of the nations in general, rather than him that hath ventured his pains and estate for the relief of the nations against so potent an antagonist." The author then points out that if it be possible (as he is willing to prove) to carry letters for one penny, it is not fair to compel men to pay three times as much, just as it would be unfair to make them pay more than the market value for food or any any other kind of merchandise. Further, if, for State reasons, a Government monopoly must be erected, "he is not the fittest man that will give the most money for it, but rather he that will undertake the service at the cheapest rate, which must be the best advantage to

the Commonwealth; and it is hoped the present Counsellors of State will eye the good and ease of the public in this particular." Hill then affirms that, in August, 1642, the restraint was voted to be illegal, and as no Act of Parliament had since been made, the posts remained legally free. He expressed a hope that, when a full and free Parliament was convened, he should be able "to convince all unbiassed persons of the unreasonableness of the farming of carriage of letters."

John Hill was an attorney of York, and in the year 1652 he "contrived the placing of horses in the road between London and York, whereby any person that had occasion to travel, might be furnished with horses and furniture at the rate of twopence for a mile, and then also at the instance of the Lord Mayor, Aldermen and others of the city of York, town of Hull, Newcastle, Durham, and other corporations, having the approbation and encouragement from the greater part of the officers of the armies then in Scotland and the northern parts of this nation, as appears under their hands, undertook the carrying of letters and small commodities at the half rates, and less than the same had at any time been carryed at, which tended much to the advantage and ease of the people; and taking to himself Clem. Oxenbridge, Esq., and other partners, they being much importuned by many citizens of London and most of the Corporations within this nation to communicate the like benefit into all the usual roads of England and Scotland, settles the same not onely in the usual roads, but also in several places where no posts formerly went."

Edmund Prideaux, who had been Chairman of the Committee of the House of Commons, formed in 1642, to inquire into the question of the posts, was appointed Chief Postmaster, in 1644, by a resolution in both Houses of Parliament; and he did not approve of Hill's proceedings. He obtained several orders to discourage the undertaking, "yet it being obvious, as well by the opinions of the judges whom the Parliaments consulted as to the point of restraint, as also by the vote of Lords and Commons, that the people had legal right to the choice of their agent," Hill and his partners continued to carry letters for one year, although, as he says, at a considerable loss to himself. When, however, Cromwell came into power, he took summary proceedings against these advocates of free trade, and put a stop to their proceedings with the help of his soldiers. This is explained by Hill in the following terms:—"The Parliament being then first interrupted, in the year 1653, the Council of Oliver, late Lord Protector, let the carriage of letters, as well foreign as inland, to a man who had neither spent money nor taken pains in reducing the same, which caused a forcible restraint by the souldiers to be put upon the said undertakers, and they compelled to desist from their lawful employment for the use and benefit of the nations, and to avoid such inconvenience as in all probability would have followed by a contest at that time when the people were so highly and (as conceived) justly discontented . . . . were content to sit still and wait till Providence should make out an opportunity." The *Calendars of State Papers* do not mention John Hill, and the summary proceedings which were taken against him, but they throw much light upon the negotiations which were entered into for the farming-out of the Post-office. In 1652, the whole question was very fully considered by a Standing Committee of the Council of State, to whom claims were made. In November of the previous year, Colonel Owen Rowe and Major Robinson offered £10,000 a year for the farming of the office.

Reasons against the farming were sent to the Committee in November, 1652, and, on the other side, "Suggestions for reducing the office into one channel for easing the people, encouraging the post-masters, and raising money for the public." The Committee reported, on November 26, 1652, that, in their opinion, "the best way for managing the foreign post-office is—

"1. By a conjunction of it with the inland post.

"2. Being so joined together, that they be committed to some person or persons to manage, on the terms proposed with reference to the inland post. That the rates for which letters be carried be as follows, viz.:—For a single letter to Ireland, 6d.; Scotland, 4d.; to all parts above 100 miles from London, 3d.; within 100 miles of London, 2d.; and so proportionately.

"3. The public letters are to be those directed to or from the Lord General, Council of State, Commissioners of the Admiralty, Generals of the Fleet, and Generals and Officers of the Army, and Commanders-in-Chief in Ireland and Scotland, also those to or from any Committee entrusted with the management of public affairs, wherein their private affairs are not concerned. The Commissioners of Excise and Customs, having their poundage for management of those affairs respectively, ought not to have their postage free. The Commissioners for the Monthly Assessments for Inspection, and the Irish and Scotch Committee, not being in that capacity, should have theirs free, provided that the letters or packets, not known by their seal, have an endorsement, 'For the service of the Commonwealth,' and be signed by the secretary or clerk.

"4. That rental be paid by the undertakers of the foreign and inland posts not to be less than £6,300, and a reasonable time to be allowed for competition by persons qualified.

"5. The time for which the trust shall continue not to exceed two years, nor be less than one."

Shortly after this Report was made, the following "Conditions upon which the Post Office is to be undertaken" were drawn up—

"1. The undertakers are to be of known integrity, and good affection, and responsible in outward estate.

"2. They are to carry all extraordinary despatches to or from the supreme authority Lord General

Cromwell, the Council of State, Commissioners of Admiralty, Generals of the Fleet, General Officers of the Army, Army Committee, and Irish and Scotch Committee, or any person entrusted with the management of a public affair wherein private interest is not concerned.

"3. All such letters by, as also those to and from all members of the legislative power are to be carried free from postage, provided that such as are not known by their seals are to have an endorsement as follows:—'These are for the service of the Commonwealth,' signed by the persons themselves or their clerks.

"4. That the sum of £ be paid by the undertakers of this business every three months.

"5. They shall receive for single letters carried into Ireland 6d., into Scotland 4d., to all parts above 80 miles from London 3d., to all parts less remote 2d., with note of the difference between single and double and triple letters.

"6. That a weekly intercourse may be continued between England and Ireland, they are to maintain one or more packet boats weekly between Milford and Waterford, and between Chester and Dublin.

"7. That besides the several post stages now in use, there is to be a post settled between Dover and Portsmouth, Portsmouth and Salisbury, London and Yarmouth, and Lancaster and Carlisle.

"The persons nominated by the undertakers for posts in their several stages, as also all other officers subordinate to them, shall be approved by persons authorised thereto by the Lord General and the Council of State."

The following offers made to the Post Committee for farming the Post-office, inland and foreign, were considered on June 29, 1653:—

Hen. Robinson	£8,041	0	0
Ben. Andrewes	9,100	0	0
John Goldsmith	8,500	0	0
Ralph Kendall	1,103	12	9
John Manley (With good security).	8,259	19	11¾
Rich. Hicks	9,120	6	8
Rich. Hill	8,160	0	0

Out of these, Manley's offer was accepted, and on the 30th of June the following order was made, "John Manley to carry all packets, public and private, inland and foreign, according to the terms agreed on between him and a Committee of Council for that purpose, and to enter on the execution of the said office to-night, and receive the profits thereof, and a warrant to be drawn for that purpose, power given him to stop all mails of letters carried by any person not authorized by him, and his office for postage of letters to be freed from taxes."

John Hill appears to have been tolerably accurate in his estimate of the value of the concession, for he sets it down at £8,000 a year, and this he considers an outside amount. He uses this as an argument for ee trade in the carrying of letters, and points out that £8,000 would be but a small addition to the public income, and could not with any advantage be set against the evils attendant upon the monopoly He writes, "A publike tax raiseth a certainty, all which ought to come to the publike use; this causeth the monopolizer, under colour of paying his rent, to hope to gain as much to himself as the first farmer, of whom it is credibly reported by farming both offices (as now they are called), in two years only he he purchased lands of the yearly value of near £1000 in fee, which must cost more money then the people of these nations concerned in commerce and correspondency could well spare. Besides, merchants and handycraftsmen deserve more encouragement then to have such a sum, or any sum, added to all other impositions. Again, the same reason may introduce the vilest and worst of monopolies, for a man may as well be restrained in sending a porter or his own known servant with a letter or upon any errand into the city or country, either by postages or otherwise, without an imposition upon every such occasion to the State. Also it hinders a man to be as civil as otherwise he would or might be, in having or returning an accompt to or from his friend, many a man in these times being forced to set a greater value of 6d. or 3d., than of three times as much in former times when money was more plentiful. And certainly any man but a farmer will confess it to be a strange imposition that a man cannot have an accompt of the condition of his wife or family without paying thrice as much as he need; and it seems as unreasonable for a man to be forced to pay 3d. for what may be done for penny (in relation to letters), as for a man to be compelled to pay thrice as much for meat or any other commodity as the price currant."

After the death of Cromwell, Hill again attempted to obtain public adhesion to his scheme, and his proposed charges compare very favourable with the Government tariff. Hill's rates were 1d. for England, 2d. for Scotland, and 4d. for Ireland; 3d. per ounce for small commodities. He proposed "that all the moneys accruing by the carriage of such letters and small commodities shall be paid to such hands as shall be appointed, and that (after incident charges, together with a reasonable allowance for his pains, be deducted) the overplus (if any) be disposed for setting the poor on work in London, York, and the country corporations, where such posts are settled, and also to give sufficient security for the management hereof (if required), and likewise to settle horses in all the usual roads to carry men with their guides at half the rates of what is now taken, viz., 3d. per mile for both the rider's horse and guide's, not doubting but it will be conceived this way of lessening the rates to be the best advantage of the Commonwealth."

It will be seen that John Hill had grasped the same idea which subsequently occurred to Sir Rowland Hill, who made it the central feature of his reform, viz., that the distance over which the letters travelled was not to be considered in the charge for postage.

Extra amounts were to be paid for letters sent to Scotland and Ireland, but in the seventeenth century these were, to all intents and purposes, foreign countries. This view was not taken officially until Sir Rowland Hill, with infinite pains, proved its truth, and caused it to be generally accepted. It will also be observed that John Hill proposed to carry parcels as well as letters, and to introduce a simple system of parcels post.

INTERNATIONAL FORESTRY EXHIBITION.

This Exhibition, which will be held next year in Edinburgh, is to include everything connected with, or illustrative of, the forest products of the world, and will be open to exhibitors from all countries. The committee will endeavour to obtain from the various British railway companies special terms for the conveyance of exhibits to and from the Exhibition. Arrangements will be made by the committee for the reception of exhibits, at a date to be afterwards fixed. Exhibitors of machinery requiring the use of water, gas, or steam, must state, on making their entries, the quantity of water, gas, or steam which will be required. Medals, money prizes, and diplomas for exhibits and essays will be awarded by competent jurors. Contributors to the Loan Department are requested to communicate with the Secretary, who will supply special forms to be filled up by them. Free space will be given for workmen's approved models. To ensure uniformity of decoration and general effect, no exhibitor will be allowed to put up any sign, flag, banner, or other kind of decoration, without the approval of the committee. A notable feature of the machinery section, says the *Scotsman*, is expected to be the display of pulping-machines, of recent invention, for making paper from wood; while scarcely less interesting will be the models of sawmills, weirs, dams, and illustrations of the methods of transporting timber down the fjords in Norway. Specimens will be shown of the various kinds of axes used for felling trees, as also of the different descriptions of machines for preparing the timber for constructive purposes. There will also be on view examples of textile fabrics manufactured from bark. The literature of the subject is likely to be illustrated by reports of the schools of forestry in all parts of the world; and in this connection occasion will be taken to show the strong claims which Edinburgh has for the establishment of such a school, the chairs necessary for the purpose being all ready to hand, with the exception of one for what may be called the "clinical" teaching of forestry; while abundant material for the practical education of students is to be found all over the country. Closely allied to this branch of the subject is the preparation of plans showing the age of trees, and the stage of growth at which cutting should be, or has been resorted to, a mode of procedure which is said to be confined in Scotland to the Grantown estate of the Earl of Seafield, under the management of Mr. John Grant Thomson, though the practice is said to be largely and advantageously pursued in other parts of the world. By the preparation of such plans, the proprietors of forests are said to have been led to take a greater interest in the woods on their estates, and so to have been enabled the better to direct their management, preventing overfelling in some seasons, guarding against overcrowding at other times, and thus rendering the plantation less liable to the ravages of such a gale as that of October 14, 1881, which levelled the famous Binning Wood. The loan section of the Exhibition will, it is anticipated, prove one of the most attractive of all, including, as it will do, notable specimens of carving, wood engraving, and the like.—*Gardener's Chronicle.*

PARIS CERAMIC AND GLASS EXHIBITION.

This Exhibition, to be held at the Palais de l'Industrie, Paris, is announced to last from August 1 till November 21, 1884, and will have three principal divisions:—

1. The technological exhibition of art industries, divided into four principal groups: stone, wood for building, earth, and glass. There will be in this division two separate competitions. (*a*) For the *ensemble* of the products exhibited. Gold, silver, and bronze medals, as well as honourable mentions, will be distributed in connection with this competition. (*b*) A competition between industrial exhibitors and artists who (while conforming to the programmes issued) shall have produced new works, models, or manufactured objects answering to the requirements of these programmes. Prizes of an absolutely new form will be given in connection with this last competition. A special section will be reserved to artists, who will be allowed to exhibit complete works under special conditions.

2. A retrospective exhibition relating to the arts dealt with in each of the four branches already referred to.

3. A competition between the pupils of drawing schools, for the grand travelling prize of the Central Union of Decorative Arts.

According to the official statements, the special competitions will be entirely independent of the exhibition, properly so-called. Each competition will have two divisions; the first, reserved to artists, will contain all the projects and models represented in the state of designs, &c.; the second, devoted to industrial representations, will only contain works in a state of completeness.

All artists and industrial competitors will be admitted to these competitions (whatever may have been the distinctions already gained by them),

provided the regulations of the programme are adhered to; but such candidates must not belong to the jury charged with the examination of the competitions, nor to the administrative council of the *Union Centrale*. No object can be received which has already appeared in an exhibition. No one can receive a recompense in the artists' section, unless he is the real author of the design which he contributes. In the industrial section competitors must have invented or executed the works sent, or caused them to be executed under their direction. All exhibits must be anonymous, but a sealed envelope is to be sent, containing the name, and corresponding by a distinctive mark with the motto or legend of the object sent.

The prizes will consist of a bronze medal for each competition, and a gold medal value £40. The latter will be awarded in a second competition, amongst those objects which have gained prizes in the separate competitions, as already described. Foreigners can compete on the same terms as French candidates.

LIGHT IN THE TEXTILE INDUSTRY.

In a treatise in the *Central Blatt für Textil Industrie*, Dr. Koller refers to the general subject of light as affecting the processes of textile manufacture, and incidentally calls attention to the different effects on colours produced by gaslight and electric illumination. In view of the rapidly extending application of electricity to the purpose in question, he dwells upon the importance, to the dyeing industry, of this fact.

As to the question of natural light, he states that when the vital conditions of organisms are spoken of, light is always understood to be one of them; and in the consideration of chemical combinations, its influence is always taken into account, light being capable of causing decompositions and combinations. The experience which has been the most fully made as to the influence of light on colours is, that numerous colours, if exposed to the light for a certain length of time, suffer in their intensity to such a degree that the original colour itself cannot always be recognised. Although this effect may partially be attributed to the action of the oxygen in the air, it is evident that this agent is not the sole cause of the effects produced, because experience has proved that colours which would fade in the light are well preserved when kept from its action.

Of exceptional importance from a practical point of view is the appreciation of the effects of light upon salts of silver, the property which they possess of becoming violet, and subsequently black, when exposed to the air, being a fundamental principle of modern photography. Dr. Koller urges the advisability of investigations being made as to the susceptible properties of other salts in the same manner, with a view of arriving at the foundation of a system of printing colours by light upon woven tissues. He calls special attention to the properties of chromic acid salts as applicable to the purposes indicated, and also to the relative effects of yellow and red chromate of potassium. Reference is made to the description given by B. Karl (in Muspratt's "Chemistry") of a method in which this principle is carried out. A tissue saturated with chromate of potassium is placed under an opaque tablet in which a design has been cut out. On the open places a genuine pale red tint is produced, while the soluble chromate of potassium is easily washed out from the other portions of the tissue. A white drawing on a coloured ground results, if an opaque object (for instance a leaf) is placed upon a transparent glass tablet; and the tissue saturated with chromate of potassium is placed under the glass.

Herr Grüne has carried his researches further, and they have passed the experimental stage, assuming a distinctly practical form. The following receipt is quoted by Victor Joclét in his handbook of "Wool and Silk Printing":—"120 grammes (·264 of a pound) of the red chromate of potassium, are dissolved in one kilo (2·20 lbs.) of water, and to the latter 60 grammes (·132 of a pound) of sulphuric acid are added. White-bleached woollen or silk tissues steeped in the solution, then dried in a rather dark room and afterwards exposed to the direct sunlight, gradually acquired a colour after about ten or twenty minutes, the shade developed being a light brown. Prussiate of potash produced a medium blue colour."

According to the same authority, Herr Grüne has discovered that the strongest shades in buff, blue, green, and grey, are produced by the ferrocyanide combinations, while chromic acid salts produce brown, violet, black, olive-green, &c.

For blue the goods are impregnated with a solution of—

60	grammes	(·132 lb.) of potassic ferrocyanide.
80	,,	(·176 lb.) of tartaric acid.
24	,,	(·052 lb.) of pink salt.

After a short time (according as the solution was made with more or less water) light and medium blue shades are developed by sunlight.

For green the following solution is used—

60	grammes	(·132 lb.) of yellow prussiate of potash.
40	,,	(·088 lb.) of sulphuric acid.
40	,,	(·088 lb.) of sal ammoniac.

Buff can be produced by the blue shade produced being passed through a caustic alkali dye, by means of which the blue is destroyed and oxide of iron remains. Grey colours are obtained by the chrome shade when produced being passed through a bath of gall-nuts, logwood, &c.

Should silk tissues impregnated with chromate of copper be exposed to direct sunlight, brown gradations of shade are obtained, which, by different coloured baths, can be transferred into shadings of grey, violet, black, and brown. Chromate of alumina gives the same results, only they are distinguished

from those obtained with chromate of copper by greater purity and vivacity in the tone of the colours.

It is finally remarked that, in the production of all these colours, the presence of moisture in the materials to be dyed by sunlight is necessary. The simplicity and cheapness of the production of such colours is perhaps not yet sufficiently appreciated, and the hope is expressed that the principle described may find more general adoption, in consequence of the publicity thus given them.

Attention is called to the fact that chromates have the property of rendering tissues waterproof. A solution of gelatine, containing 2 to 2½ per cent. of chromate, can be used in the finishing and waterproofing of linen, silk, and cotton materials. If a tissue saturated with a solution of this kind, and then dried, is exposed for a short time to the light, it is rendered perfectly waterproof. Dr. Koller thinks that this property of the chromic salts is capable of being utilised for many important purposes.

THE PRODUCTION OF SIENA EARTHS.

Consul Colnaghi, in his report on the mineral products of the province of Siena, says that Siena earths, known also under the names of ochre, bole, umber, &c., are considered by some mineralogists to be ferruginous clays, by others, minerals of iron. They are chiefly found in large quantities in the communes of Castel del Piano and Arcidosso. The yellow earths and bole found on the western slopes of Monte Amiata are true lacustrine deposits found amid the trachytic rocks, of which it is principally composed. They lie under, and are entirely covered by the vegetable soil. Varying in compactness and colour, they are termed yellow earths when of a clear ochreous tint, and *terra bolare*, or bole, when of a dark chestnut colour. Each deposit consists for the greater part of yellow earth, beneath which bole is found in strata or small veins. The mineral being very friable, its excavation is easy, and is generally conducted in open pits. The different qualities are separated during the process, the bole which has the higher commercial value being the more carefully treated. After the first separation the bole is further classed into first, second, third, and intermediate qualities—*boletta*, *fascia*, *cerchione*, &c. Its most important characteristic is termed, in commercial language, *punto di colore*, or tint. The value of the bole rises as its tint deepens. Thus bole of the third quality is lighter than that of the second, and the second than that of the first. After the third quality comes the *terra guilla*. The yellow earths, after excavation, are exposed to the open air for about a year, by the pit side, without classification. The bole, on the contrary, is placed in well ventilated storehouses to dry for about six months. This diversity of treatment is owing to the fact that exposure to the elements brightens the colour of the yellow earths, and raises their value, while it would damage the bole by turning its darker tint first into an orange yellow, and if continued, into an ordinary yellow earth. It also loses in compactness and crumbles up under exposure. In addition to the *punto di colore*, the size of the pieces influences the commercial value of the bole, which increases with their volume. Thus the classification is *Bolo pezzo*, *Bolo grapolino*, and *Bolo polvere*. The yellow earths are classed as *Giallo in pezzi*, *Giallo commune*, and *Giallo impalpabile*, the impalpable being worth more than the common yellow. The production of the Siena earths is estimated at about six hundred tons per annum, of which amount about fifty tons are calcined, and the rest sold in their natural condition. The value of the trade is estimated at from £4,000 to £6,000.

General Notes.

Steam Tramways in Sydney.—Steam tramways, have been recently introduced in Sydney. The motors, obtained principally from America, are compact, light, and of considerable strength. The carriages are double-decked, the seats on the roof being under shelter. At the close of 1881, there were 11¼ miles of tramway in actual use, the number of passengers during the year being 7,090,125, as against 2,086,897 during the previous year. In 1882 there was a further increase, which is said to be maintained during the present year.

School of Art Wood-carving.—The school in connection with the City and Guilds of London Institute for the Advancement of Technical Education has re-opened after the usual summer vacation, and the Chairman of the Committee, Colonel Donnelly, R.E., states that some of the free studentships, both in the day and in the evening classes, which the committee are enabled to offer in consequence of the aid afforded to the school by the City and Guilds of London Institute, are at present vacant. Orders for carving are executed at the school, designs and estimates being supplied, and the committee would be glad to co-operate with architects in the execution of designs for internal decorative wood-carving, a branch of the art which they especially desire to develop. The school is open to amateurs, as well as to those who intend making wood-carving a profession. To those amateurs who are unable to attend the classes, information can be given by letter, and examples supplied. All necessary information, with forms of application and prospectuses of the school, may be obtained by personal application or by letter, addressed to the Manager, School of Art Wood-carving, Royal Albert Hall, Kensington, S.W.

Journal of the Society of Arts.

No. 1,613. Vol. XXXII.

FRIDAY, OCTOBER 19, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

UNION OF INSTITUTIONS.

The following Institutions have been received into Union since the last announcement:—

Preparatory Institute, Aberdeen.
Science and Art Institute, Walsall.

Proceedings of the Society.

CANTOR LECTURES.

THE TRANSMISSION OF ENERGY.

By Prof. Osborne Reynolds, M.A., F.R.S.

Lecture III.—Monday, May 7th, 1883.

So far I have spoken only of the conveyance of power by means of coal, corn, or in one or other of the several forms of packed energy. To-night I come to consider the transmission of power by what are more distinctly mechanical methods, and by currents along pipes and conductors. These are the means by which power is almost always distributed, *i.e.*, transmitted from the acting agent, be it horse, water-wheel, or steam-engine, to its operation, whatever it may be. In most cases the distance of such transmission is so short as to be the subject of small consideration in determining the means to be employed. That is to say, the means are chosen rather by their adaptability to receive and render up the power than by the efficiency with which they transmit it. Thus, if we take an ordinary mill, the shaft which receives the power from the engine is generally driven at that speed which is best adapted to receive the power from the engine, and deliver it to the machinery in the mill, without considering whether a much smaller shaft might be used if it were caused to run at a much higher speed. Thus, in a mill driven by an engine of two or three hundred horse-power, the shaft which receives the power will generally be five or six inches in diameter, whereas it would be possible to use a shaft of two inches diameter if the efficiency of the shaft were the only consideration. Or, again, take a screw steamboat. The distance from the engines to the screw may be 250 feet, the power 10,000 horse. This could be transmitted by a shaft twelve inches in diameter, if allowed sufficient speed, but the screw has to make sixty revolutions per minute, and this determines the speed at which the shaft is made to run, and hence the shaft is made thirty inches instead of twelve inches. This is because, owing to the smallness of the distance, the efficiency of the means of transmitting the power is a small consideration. There are, however, many circumstances under which it is impossible to bring the source of power close to its work, and then either mechanical power is not used, or the efficiency of the means becomes a consideration.

In other cases it is a question whether it is better to distribute the sources of power, such as steam-engines, so that they may be near their work, or to use one large source, and distribute the power by some mechanical means. This rivalry exists in almost all engineering work which covers a large area, and, generally, a compromise is come to, engines being distributed about the works, and the power of these distributed to the machines by means of shafting. In many cases separate engines are used for each machine, but not often separate boilers, the power being distributed by steam-pipes.

Dockyards have long afforded a field for the competition of the various means of distributing power. Here, generally, the distances between the operating machines, such as cranes and capstans, is considerable, and the work required from each machine very casual. And every means of distribution is or has been in use, from a separate engine and boiler to each machine, as at Glasgow (separate engines drawing their steam from central boilers), to a complete system of hydraulic transmission from a central pumping station, as at Grimsby or Birkenhead.

But the question between centralisation or distribution of steam-engines is not by any means the only one, or most important one, which depends on mechanical means of distributing power. Every improvement in the means of distributing power from a central engine opens a fresh field for its use.

The considerations relating to this subject are numerous. Hitherto, as regards the main transmission of power, the principal consideration has been the per-centage of loss according to the distance; but, as regards the final distribution of power, the form in which it is distributed must be such as admits of its being at once available for its purpose. Thus hydraulic distribution is favoured in dockyards, because it is required for heavy forces and slow motions, but where rapid motion is required, hydraulic distribution gives place to some other.

Again, where the quantity of power that has to be distributed is a most important consideration, the distribution by means of water or compressed air will generally be the most efficient, whereas these would be by far the most costly means for small quantities. It thus has to be remembered that, besides the general question of efficiency, each means has particular recommendations for particular purposes.

It is not, however, with these particular recommendations that I am concerned. My object is to show the limits within which the use of each means is confined, however fit it may be for its purpose. Taking first the mechanical means, which are shafts and ropes, we find that the possible limits to both these means are absolutely defined by the strength of material. The amount of power any piece of material will transmit by motion against resistance, is simply the mean product of the stress or force acting in the direction of motion on the section multiplied by the velocity, so that, if the stress is uniform over the section, the work is the product of the area and intensity of stress and the velocity.

In a revolving shaft, neither the stress nor the velocity are uniform over the section, both varying uniformly from nothing in the middle to their greatest value on the outside; so that their mean product is exactly half the product of the greatest values. The greatest power per square unit of section a shaft can transmit is half the product of the greatest stress into the velocity at the outside of the shaft.

Taking, then, the greatest safe working stress for steel at 15,000 lbs. on the square inch; taking what is the greatest practical velocity at the surface, 10 feet per second (the speed of railway journals); the work transmitted is 75,000 foot-pounds per secoud per square inch of section—135 horse-power; so that we should have to have a shaft of upwards of 7 square inches in section to transmit 1,000 horse-power, that is, a shaft of over 3 inch diameter. The friction between such a shaft and lubricated bearings is well-known, ·04; so that, calculating the weight of the shaft 24 lbs. per foot, we have power spent in friction about 52,000 foot-pounds per mile, that is one-tenth the total power the shaft will transmit. That is, if we put 1,000 horse-power into a 3-inch shaft, making 500 revolutions per minute, we ought, at the end of a mlle, to be able to take 900 horse-power out of it. If we had to go farther, the size of the shaft might be diminished, so that in the next mile we should again lose a tenth, and if we repeat this process seven times, we shall, at the end of seven miles, have left about half the original power put in.

It will be thought, perhaps, that a 3-inch shaft is very small to transmit so large a force; this is because the speed of 500 revolutions per minute is inconveniently high for purposes of employing the power; but if it were merely a question of transmission, it would be about the best speed. This, then, shows the limit of the capacity of shafts as transmitters of work.

Turning now to steel ropes, these have a great advantage over shafts, for the stress on the section will be uniform, the velocity will be uniform, and may be at least ten to fifteen times as great as with shafts—say 100 feet per second; the rope is carried on friction pulleys, which may be at distances of five or six hundred feet, so that the co-efficient of friction will not be more than ·015, instead of ·04. Taking all this into account, and turning to actual results, the work transmitted per inch would be 1,500,000 foot-pounds per second; or that a $\frac{3}{4}$-inch rope is all that is necessary to transmit 1,000 horse-power in one direction, this would make the loss per mile only 1-60th. But in practice, rope has to be worked backwards and forwards, and the tension in the backward portion of the rope must be half the tension in the forward portion. This reduces the performance from 1-60th to 1-20th, which would cause half the work to be lost in ten miles. If we use a bigger rope, and run at lower speed, then the co-efficient of friction would be reduced to 0·1, and the distance extended to fifteen miles.

Experience with ropes is large, and they have been found, without question, to have

been the most efficient mechanical means of transmitting power to long distances, but their use is subject to drawbacks. The ropes wear somewhat rapidly, as do also the pulleys on which they run, and this circumstance is very much against their use in any permanent work. Nevertheless, they are used for working mines, steep inclines, and steam ploughs; while at Schaffhausen they have been used for transmitting power to considerable distances.

Turning to the transmission of power along pipes, we find the conditions somewhat modified. The formula for the amount of power transmitted by water is the same, namely, the product of the area of section into the velocity. But the resistance obeys different laws. In the case of shafts and ropes, we have seen that the distance is subject to an absolute limit.

In the case of fluid in pipes this is not so. No matter how long a pipe may be, if there is no leakage, water would flow along the pipe until the level of its surface were the same at both ends. But the rate of flow would diminish with the length and diameter of the pipe. Thus we can transmit power through a perfectly tight pipe, however small, and however long; but when we come to consider the gross power that can be transmitted through a given pipe, with a given per-centage of loss, the question is different. Given the size and strength of the pipe, the gross amount of power, and the per-centage of loss, and the limits are fixed. Thus, taking a 12-inch pipe capable of standing 1,400 lbs. on the square inch, the loss in transmitting 1,000 horse-power would be about 5 per cent. per mile, at first increasing—as the pressure fell to 700 lbs.—to 10 per cent. We should thus have lost half the power in about seven miles. We cannot say that seven miles is the absolute limit, for with a 24-inch pipe, which would cost four times as much per mile, we could transmit the same power thirty times as far with the same loss. The cost of laying a 12-inch pipe for seven miles, however, would probably be as much as even 1,000 horse-power would stand; while a 24-inch pipe for 200 miles would be out of all proportion. Then there is the consideration of leakage, which, although very small for short lengths, is larger for greater lengths.

Seven miles is at present an outside economical limit of hydraulic transmission, even for such a large amount of power: but with air the case is different. This flows so much easier than water, that the cost of transmitting the same power through the same distance, with the same loss, would be about 12 per cent., or, at the same cost per mile, the air may be transmitted 100 times as far with the same loss. The total cost, however, would thus be 100 times as great, which would exceed the economical limit; but not only theory but practice has shown that power may be economically transmitted five times as far by air as by water—something like thirty miles. But on comparing these two means, one circumstance must not be lost sight of, and that is, that getting the power into the pipe in the form of compressed air, will cost twice as much as getting it in in the form of water. This is a great advantage for water where the distance is short, but where the distance is long, the greater efficiency of air more than compensates for this initial loss.

Like water, air can only be transmitted economically where the quantity is large, the friction being proportionately greater in small pipes than in large, varying as the four-fifths power of the diameter.

This is a great drawback, both as regards hydraulic and compressed air transmission. It does not affect ropes and shafts in the same way, but even in these cases considerations of durability prevent these means being used efficiently for the transmission of small quantities of power to considerable distances, so that, with the possibility already mentioned, there remains an opening for any means that will enable power to be transmitted efficiently in small quantities, and such a means we have in the flow of electricity along wires or conductors. In considering electricity, we may well start with the questions—1. Will electricity enable us to transmit power in large quantities more efficiently than the foregoing means? 2. Will it enable us to transmit small quantities? These questions may be more definitely answered than they could a few weeks ago. Thanks to the experiments of M. Deprez, who appears to have been the only one, out of all those who are advocating the use of electricity, who has had the courage to try and see what can be done, we can now say with certainty that a current of electricity, equivalent to 5 horse-power, may be sent along a telegraph wire 1-6th of an inch in diameter, some ten miles long (there and back) with an expenditure of 29 per cent. of the power, because this has already been done. In order to do this, it would seem that M. Deprez has perfected his apparatus so as to have nearly reached the possible limit. Compared with wire rope, this means falls short in

actual efficiency, as Messrs. Hems sends 500 horse-power along a ¾-inch rope. To carry this amount, as in the experiment of Deprez, one hundred telegraph wires would be required; these wound into a rope would make it more than 1·4 inches in diameter, four times the weight of Mr. Hems's rope. With the moving rope the loss per mile is only 1·4 per cent., while with the electricity it was nealy 6; so that, as regards weight of conductor and efficiency, the electric transmission is far inferior to the flying rope. Nor is this all. With the flying belt, Mr. Hems found the loss at the ends, in getting the power into and out of the rope, 2½ per cent.; whereas, in M. Deprez's experiment, 30 per cent. was lost in the electric machinery alone, which is very small as such machinery goes. But this is not all. No account is here taken of the loss of power in the transmission to and from the electric machinery, a matter which is, I believe, very much under-estimated.

The machines made revolutions at 1,000 and 700, much too high for direct connection with either a steam-engine or any mechanical operator; the power, then, had at each end to be transmitted through gearing, or a system of belts. And supposing this alteration of speed to have been five or six at each end, experience tells us that a loss of at least 15 per cent. must ensue. This loss was indeed apparent, for the dynamometer was connected with the machine with a belt, which showed a loss from this one belt alone of 20 per cent. Taking the whole result, it does not appear that more than 15 or 20 per cent. of the work done by the steam-engine could have been applied to any mechanical operation at the other end of the line, as against 90 per cent. which might have been realised with wire rope transmission. To set off against this, electricity has the enormous advantage in the conductor being fixed, and in the fact that it is likely to be, if anything, less costly and more efficient for small quantities of power than for large. These advantages will certainly insure a very large use for electricity in the distribution of power, particularly for high speed machinery.

There is yet another means of communicating and distributing energy now coming rapidly into vogue. This is by the transmission of coal gas along pipes. The distances, often many miles, through which the gas is often transmitted before reaching the engine, are such that, with any other means of distributing power, would considerably enhance the cost of the power. But in the case of gas, it does not appear that these distances are at all a matter of consideration. This may be at once explained. It takes about ten cubic feet of gas to develop 1,000,000 foot-pounds in a gas-engine, whereas of air compressed in the ordinary way it would require something like 140 cubic feet to yield the same power. Hence the comparative cost of transmission is the cost of transmitting ten cubic feet of gas against that of 140 cubic feet of compressed air, and these would be about as one to twenty-five; so, as a means of distributing energy, gas is twenty-five times more efficient than compressed air.

I have now placed before you, as far as circumstances will allow, the various means by which energy, in a form available for power, may be transmitted over long distances, together with the circumstances which limit such transmission. By means of the railway and steamboat, corn and coal can be, nay is, transmitted half way round the earth with an expenditure of power of less than half the power represented by the coal carried, but this can only be done where the quantity to be transmitted is very large.

At present the efficiency is unrivalled, no means of packed energy or of current energy approaching even 1 per cent. And further, there is apparent room for a large diminution in the present expenditure, small as it is, in the improvement on the steam-engine as a means of directing the energy of coal. For the distribution of power, this means ceases to be efficient, nor can it be employed to transmit energy which has already taken the form of of power. For these purposes other means have to be employed. These various means, although they differ greatly in efficiency, all fall so far below the efficiency of coal and corn, that a hundred miles appears to be the outside limit any economical transmission of power, in quantity for mechanical purposes, could be at present effected; and hence any power, be it derived from wind or water, must be used within this radius of its source; and, except in places far out of the reach of rail or water, this limit may be divided by ten.

So far as efficiency of transmission in considerable quantities, neither secondary batteries nor electrical transmission are more efficient than compressed air or belts, but when it comes to transmitting small quantities, then electric transmission has a decided advantage. The cost of the electric conductor diminishes with the quantity to be transmitted, and by making

the conductor sufficiently large, its efficiency may be increased to any extent.

At the present time, electric conductors are continuous half way round the world, and whenever a message is sent from England to Australia direct energy is transmitted 10,000 miles, but in what quantity? The energy of the current, as it arrives, is not much more than sufficient to keep a watch going, at any rate not more than 1-1,000 millionths of horse-power. The value of such energy, estimated at £17 per minute, would be equivalent to a billion pounds per horse-power per hour, whereas the highest price paid for animal labour in Australia or England is not more than 6d. per horse-power per hour. This shows the difference between the transmission of electricity for telegraphic purposes and its transmission for mechanical purposes. Energy differs in value greatly, but for operations that can be performed by men or horses, the price of energy must be regulated by the highest price of corn.

The prosperity of any spot in the past depended on the fertility of the adjacent soil. But the use of coal has altered this, and now the present prosperity of this country is owing to the adjacency of our coal-fields, these having rendered it possible to bring our food across the earth. The improved means of transmitting coal and corn, it would seem, have, or may again, change this, and if, instead of looking on the life of this country as limited by the life of our coal fields, we look boldly forward, and foster every means, political, social, and mechanical, which may render this a favourite spot to live upon, we need not fear that the necessity of bringing our coal from a distance, will make a difference which will counterbalance the advantage we shall derive from the mechanical facilities we shall have here.

Miscellaneous.

REVIVAL OF VENETIAN INDUSTRIAL ARTS.

H.M. Vice-Consul at Venice, in an account of the revival of Venetian industrial arts, says that the art of manufacturing glass appears to have been brought to the Venetian lagoons by the early settlers from the mainland. Glass-making has been always the principal industry of Venice and Murano, and some of the Venetian productions have long enjoyed a world-wide fame. Beads, spun glass, blown glass, enamels and mosaics, looking-glasses, &c., are all made in Venice. It is said that the invention of beads dates from the thirteenth century, and is due to two Venetians—Miotti and Imbriani—who were urged to make experiments by the celebrated traveller, Marco Polo. Under the Republic, and for some years after its fall, the exportation of beads had not reached the importance it has attained, owing, in a great measure, to the smallness of the furnaces, and to the difficulty and length of the technical processes required for the composition of the paste. The Morelli, however, who, in 1670, were the principal bead manufacturers, had four ships at sea carrying beads to the East on their own account; and they became so rich that they have been allowed to enter the rank of the Venetian nobility, on payment of a sum of 100,000 ducats to the Republic. Since 1815, this industry has become of sufficient importance to give, at the present time, employment to about 15,000 persons. The traffic is carried on with all the world, but the principal exportation of beads is to the ports of Asia and Africa. Beads are sold under the following denominations: *conterie in perle*, which are small perforated balls, made either of glass or enamel; *jais*, glass tubes of very small bore, cut into short lengths; *pipiotis*, *jais* cut into facets; and *mezzi*, a sort of *pipiotis* made in a mould. The wages in glass-works are, for a first hand, about eight francs a day; for a second hand, four francs and a-half; and for the ordinary workmen, from two to three francs a day. During the last five years the average annual exportation of beads has been about 2,500 tons, of the approximate value of £220,000. The almost lost art of glass-blowing, which flourished at Murano during the early part of the Renaissance, and the decay of which was due to the growing taste in the 18th century for the imitation of crystal, has only been revived of late years. The products of this branch of industry are known under the name of *soffati ordinari*, which are blown bottles, glasses, and other articles for domestic purposes; and *soffati artistici*, artistic ware of all shapes, admirably fashioned after the old models or in modern forms, richly decorated, occasionally with grotesques, and enlivened with delicate and brilliant colouring. Nearly all the kinds of ware known as Murano, such as *filagrana*, *fiamma*, *ritorte*, *opale*, *merlate*, *reticelle*, &c., have been successfully reproduced by the modern artificers. The art of working in mosaics was probably known in very early times, and there is no place in the world where this art has been more cherished than at Venice. Byzantine and Greek artists revealed to the Venetians all its secrets, and in Venice was founded the school of mosaicists who, for centuries, have covered the Basilica of Saint Mark with masterpieces of decoration. The glory of bringing the mosaic art to its height is due to the

brothers Francesco and Valerio Zuccato, sons of Sebastiano Zuccato, master of Titian, who flourished in the 15th century. These artists executed their mosaics on cartoons drawn by themselves and by the most celebrated artists of the period. Ancient mosaic work was divided into *lithostratum*, *vermiculatum*, *alexandrinum*, &c., according as it was made of marble or other precious stones, and according to the figures and designs it represented. Modern mosaics are now distinguished under the two following heads—inlaid mosaics, and monumental or Byzantine. The former, which is made thoroughly smooth by fixing on to the cement the stone or enamel pieces with their edges perfectly close, and adhering together, and by the subsequent polishing of the entire surface of the work, is generally used for making personal ornaments, or fancy goods. The second is made of pieces which, not being cut into regular or geometrical shapes, cannot be closely united one to the other. This was the mosaic generally used by the ancients, and has now been adopted for architectural decorations. Coloured enamels for mosaics are composed of the same ingredients of which glass is made, with some other mineral substances, which, when fused with them, impart to the vitreous paste the required degree of opaqueness and colour. Thus they are rendered blue by oxide of cobalt; yellow by oxide of lead, uranium or wood-coal; green by oxide of iron, or of chrome, &c.; but the greater or less degree of their hardness or opaqueness, and the quality and beauty of their colour, depend also on the degree and continuance of the heat to which the composition is subjected in the furnace. Gold and silver enamels are made in a different manner. On the flat surface of a piece of thick glass or enamel is laid a leaf of gold or silver, which is made to adhere by the action of heat. A delicate film of the purest glass, either transparent or of any shade of colour, is then spread over it. When the three layers are fused, they become thoroughly united, the metal, however, appearing in all its brightness, the glass with which it is covered being nearly imperceptible. There are, at present, in Venice, three great establishments engaged in making mosaics for artistic mural decorations. Among the recent works executed by one of these establishments, are the restoration of the old mosaic, "Visions of the Apocalypse," in the Church of St. Mark; the entire reconstruction of two superb mosaics of the 12th century, in the ancient Cathedral of Torcello; and the reproduction of the "Good Shepherd," a celebrated mosaic of the 8th century, existing in the tomb of Gallia Placidia at Ravenna. Other less important factories also exist, which produce mosaics, representing flowers, fruits, animals, landscapes, &c., and these are chiefly made into brooches, bracelets, tables, and other similar articles. Another art which has lately been revived with great success is that of fusing metals, for the production of articles which flourished at Venice at the time of the Renaissance. Thirteen factories are now reproducing, after ancient models, artistic bronzes, candelabra, plates, armour, swords, etchings, chiselled works, &c., for which there is a considerable demand not confined to Italy. A new feature of Venetian industry, which also appears to be largely encouraged, is the imitation of antique furniture in ebony and ivory, for which materials pearwood and bone are substituted. The lace industry, once so celebrated in Venice, and which had altogether sunk into decay, has been revived. Schools and manufactories have sprung up, and about 3,000 women at Venice, Palestrina, Murano, Burano, Chioggia, and Caorle, are now employed in lace-making; their earnings range from fifty centesimi to four lire a day, and the value of the lace produced amounts to 200,000 lire per annum. Another specialty of Venice is the imitation of old damask. In the days of the Republic, the Venetian looms produced magnificent stuffs, embroidered with gold, silver, or silk, which the Doges sent as gifts to foreign potentates. The art, which was entirely lost, was rediscovered in 1857, and is now recovering some of its ancient splendour.

UNDERGROUND WATERS.

The Ninth Report of the Committee for Investigating the Circulation of Underground Waters in the Permeable Formations of England, and the Quantity and Character of the Water Supplied to Various Towns and Districts from these Formations, was read at the Meeting of the British Association, Southport. The following Report was drawn up by C. E. de Rance:—

"Ten years having elapsed since the Committee was appointed at Belfast, they think this a fitting opportunity to review the results so far obtained, and to point out where they consider additional information is still required, in the hope that they may receive assistance in their investigations from the various local societies, or from individuals who may be disposed to aid in the work.

"The work entrusted to the Committee was twofold—first, to inquire into the circulation of underground waters in permeable formations; secondly, to ascertain the quantity and quality of the water supplied to towns and districts through these formations. The information obtained occupies nine reports; the eight already published fill up no less than 163 pages of the annual volume of the Association, and contain a record of upwards of 500 wells and borings.

"The Committee believe that the publication of these results, by directing public opinion to the value of such supplies, and by the preservation of the records of those carried out, has given an impetus to water of this class being generally adopted for domestic consumption in districts where gravitation supplies are unsuitable or unattainable.

"As regards the first head of inquiry—the circulation

of underground water—much remains to be learnt, especially as to the influence of variation of barometrical pressure on the volume of springs. Independent investigation is now being carried on by Mr. Baldwin Latham, but it is exceedingly desirable that numerous observations should be taken in different classes of rocks, the quantity of water a rock is capable of holding being no measure of the quantity of water it is capable of yielding. The difference of the period of time in which two rocks will absorb and give off by gravity the same quantity of water, is governed by the difference of their chemical composition.

"The chemical composition of two rocks being identical, their facility of discharge of water is in direct relation to the amount by which they are traversed by planes of joints and fissures, and the extent these may run parallel or at right angles to the valleys which cut into and expose the water-bearing beds.

"The proportion of the annual rainfall that is absorbed by different classes of rocks is a subject that requires further examination. The quantity is largely regulated by the quantity stored from previous years. After a succession of dry years, the permanent water-level is reduced to minimum figures, and the water-gradient becomes nearly flat, and springs cease to flow. The first heavy rains will be nearly wholly absorbed, until the maximum water-gradient is reached and the rocks are stored with the largest amount of water they can hold. After they are once charged, all excess of rainfall runs off in floods, and the amount absorbed is practically *nil*. Spread over the twelve months, the annual amount absorbed is probably never more than 15 inches, and the average ranges from 5 inches in chalk countries to 10 inches in new red sandstone areas. In millstone grit districts about 8 inches are absorbed, but the permeable beds are thin, and the water is thrown off again in numerous springs, as a rule in the same drainage basin, giving permanence to the dry-weather flow of the streams traversing them. Except in waterworks drainage areas, but few observations exist as to the actual volumes run off daily by the rivers of this country, and data on this subject are much required, as well as a permanent record of the height to which floods rise in the various river basins.

"Further observations are required as to the action of faults in acting as ducts, along the face of which water is constantly passing, and barriers separating districts into distinct drainage areas. The facts so obtained point to faults traversing thick permeable sandstone and limestone, having these formations on both sides of the dislocation, as offering no obstacle to the free passage of waters, which even if locally obstructed by the hardened face or slickenside jointing of the fault, invariably finds its way through cracks extending across the width of the fault. In faults traversing thick shales and clays of any age, the fissure, be it wide or narrow, always appears to have been filled with the impermeable material forming the sides, and in some cases, when porous rocks have been immediately overlaid by impermeable material since denuded, the fissure of the fault has been filled from above at a time when the fault had an upward prolongation, destroyed with the denuded material referred to.

"The daily registration of the heights of the streams might easily be made on gauges painted on the county bridges, but the organisation necessary to carry this out is entirely beyond the scope of the British Association, and should be carried out at the national charge, being of the highest importance to the country.

"The determination of the number of cubic feet of water carried down at selected points on the English rivers, particularising whether it represents dry-weather, average, or flood-flow, would be of very high value, and might well be undertaken by the Association. Such observations, stating the run off per square mile of drainage area and the geological character of the area drained, would have more than a local value.

"Permeable rocks below the permanent water-level of a district may be regarded as a reservoir, of which the cubic content is limited by the size of the spaces between the grains, and the width of the fissures and cracks by which the rock may be traversed. The quantity of water such rocks are capable of storing, has had much light thrown upon it by the investigations of Mr. Wethered, published in the fourth appendix to the eighth report."

FISH CULTURE IN CHINA.

From a report just issued by the Inspector General of Chinese Customs, it appears that the various treaty ports on the coast of China are all, more or less, important centres for fishing, but Swatow enjoys in itself, on a small scale, all the advantages which are distributed along the sea-board. Swatow is situated at the north-eastern corner of the province of Kwang-tung, near the frontier of Fukien. The river Han, which forms above Swatow a vast estuary, flows past the city, and joins the sea a few miles below the town. Fort Island, Brig Island, Double Island, and Namoa flank the mouth of the river. The first three are important stations for curing the fish; the last-named station sends forth daily large fleets of boats, which proceed to the fishing grounds about eighteen miles distant from the island. On the part of the Government, no restrictions are laid on the fishing grounds; fishing is carried on all the year round, and no regulations hamper the fishermen in the use of their nets or lines, only a small tax having to be paid for a license. The season for deep-sea fishing extends from the seventh Chinese month (August), to the third Chinese month (April). Nets and hooks are the implements used by the fishermen on the high seas. The nets are made by the fishermen themselves, in their homes, and all the members of the household

assist at the work. Hempstring of different strengths s the material employed, and the manner of knitting and the needle used are the same as in Europe. From the raw hemp the fibres are peeled by means of the finger nail, and the strips are then put into water to get well bleached. On the spinning wheel, the single strips are thrown into thread ready for use. When the net is completed, it is dyed and steamed in a solution of mangrove bark, and soaked in pig's blood. The most important stations on the mainland for deep-sea fishing are Tatapou and Haimên. At Tatapou the boats are divided into the following classes:—The *ta-tsêng*, carrying a crew of six men; the *ch'ien tsêng*, five; the *ao tsêng*, four; the *li niao*, three; and the *tiao ts'ao* carrying five or six men. At Haimên the fishing boats are divided as follows:—The *ch'ien tsêng*, carrying a crew of six men; the *niao wang*, four men; and the *nei wan*, also four. At Tatapou and Haimên the largest boats always go out fishing in pairs, dragging the long trawl net between them, the smaller craft fish singly with nets and hooks; these boats are never away from port more than one day, and on their return the fish are put up for sale on the beach. When proceeding to sea at night, signals are made with incense sticks, which burn like torches, to regulate the movements of the boats. On the island of Namoa a different mode of fishing is pursued. There the boats proceed to sea in groups, each group being led by two large boats called *ch'eas ku*, and followed by about forty-five small ones. A *ch'eas ku* has generally a crew of fifteen men, and each small boat three or four men. The big boats drag the net, and the small boats assist in hauling it up, their movements being all regulated by the leaders or mother boats. By day the signals are made with flags, at night lanterns are used, and the position of the latter at the mast-head serves as a guide for the boats belonging to the same company. As soon as the nets are thrown out, the small boats form a vast enclosure round them, the sailors striking on bamboo poles to rouse the fish from their retreat, and to drive them into the net. On a given signal, the small boats gradually pull nearer the centre, and then the net is hauled up. During the fourth, fifth, and sixth Chinese months (May, June, and July), the boats proceed to sea in pairs, instead of in groups, and fish for cuttle fish, and as bait use cuttle fish cut into very small pieces, or cockroaches. At Tatapou, Haimên, and Namoa, the crews of the boats participate in the haul, and their wages are calculated according to the result, but at each place a different system of division is pursued. In the district of Swatow, fishing is extensively carried on with stake nets. The stakes, are heavy beams driven into the ground thirty feet apart, and are kept together at the surface by means of a strong bamboo rope covered with straw. The nets are only set during ebb tide; a few boats are generally moored near the fishing stakes, to keep up communication with the shore. These boats are about thirty-five feet long, so as to reach from one beam to another, in order to facilitate the hanging up and taking away of the nets. In the nets bamboo baskets are suspended, with the opening towards the net, and the baskets are surrounded at their inner surface with a girdle of bamboo staves. The fish trying to escape from the net are caught in the baskets. Near the island of Namoa are the largest fishing stakes in China. In the river and canals, fishing is carried on in various ways. The large flat dip net, the casting net, the small dip net, and the weir, together with hooks and lines, are the implements most frequently in use. Fishing with the large dip net is attended to mostly from the shore. The net is spread over moveable bamboo poles attached to pegs in the ground, and ropes lead from the ends of the net to a wheel in the hut of the fisherman on shore. From time to time the latter raises his net above the water by turning the wheel, and advancing from his hut along a plank to the net, takes the fish with a small scoop. In fishing with the casting net, the fisherman stands either on shore or in a boat in which a companion uses the oars. The weirs are often of different sizes, and are made of poles, to which rolls of bamboo matting are attached; these are unrolled and set up at high water, and with the falling tide the fish are gathered in. The space enclosed by a weir may be easily extended, it being only necessary to unfold more rolls of bamboo matting. Each corner of the weir is formed into a series of alleys; the fish, trying to find an outlet, enter the alleys, where they are caught, and removed by means of a scoop net. For crab fishing, a trap is used of very ingenious construction. It is made of bamboo, and has the shape of a truncated cone; just within the top is a girdle of bamboo staves, falling on each other in the shape of a cone; the bottom of the trap is moveable, so as to allow of the withdrawal of the crab. In the middle of the basket the bait is kept between two staves, and, as bait, an oyster is generally used. The baskets are suspended on a long rope, extending between two floating buoys, and in order to sink them in the water a set of heavy shells are made fast to the rope. Shrimps are caught in much the same way; though the baskets are not perforated, the system is the same. The baskets are spread on the muddy ground near the shore, the opening is surrounded by a set of staves, and the lower end is closed by a bundle of straw. Another method of catching fish which is extensively practised in the upper regions of the Han and the rivulets which join it, and which is recognised as a legitimate mode of fishing, is to poison the water, and thus drive the fish to the surface. As regards the rearing of fish, the wealth of the sea and river in fish in the district of Swatow appears to be so enormous that hitherto artificial hatching has not received much attention. Fish ponds are, however, to be met with all over the district, and appear to give a profitable return to the owners. The ponds are always dug in shady places, and are not very deep. At the bottom a small excavation is made, where the fish can retreat in

cold weather. The sides of the ponds are always rough, for it is the general belief among the owners that the fish would not grow in a pond the sides of which were smooth. Around them, trees having a large foliage are generally grown, and rockeries are built within, to afford hiding-places to the small fish. In the early spring the fish ascend the rivers and canals for spawning. They deposit their eggs on the grass and herbs near the shore, and after a very short time the young fry come out of the egg. The fry are caught with a very fine net, and first deposited in a tank, where they are fed with the yolk of egg; when they have grown a little they are transferred to the ponds, where they are kept until large enough to be disposed of in the market. In winter, when the temperature of the water has cooled to such a degree that it becomes detrimental to the fish, earthen stoves are suspended above the surface, to warm the water.

MANUFACTURE OF STRAW GOODS.

The New York Hatter and Furrier contains an article on the past and present manufacture of straw goods in America, from which it appears that the straw business, as a manufacturing enterprise in America, started with Fisher and Day, at Wrentham, Mass., in 1804.

Statistics give the number of bonnets made in 1837 as 4,000, with a value of $12,000. In 1845, the value of braid made in Milford was $12,500, while the value of bonnets produced had decreased to $1,500. In 1875, with only one manufactory, the capital invested had increased to $30,000, and the value of the goods to $190,000, employing in the production 16 males and 168 females. These figures are said to be much below the present plant and worth of goods, with three establishments, employing some 600 people, both male and female.

Relatively the same increase in the volume of business can be noted in the other towns where the industry was started in the early days, and nearly all have contributed in a large degree to bring it up to its present condition as an important factor in industrial history. Twenty-five years ago, the following towns were credited with a production in straw goods valued as below :—

	dols.
Amherst	32,000
Medfield	60,000
Mansfield	110,000
Medway	100,000
Franklin	405,000
Palmer	10,000
Manson	120,000
Middleboro	25,000
Upton	250,000

All in Massachusetts. Foxboro was producing 2,000,000 hats and bonnets, whose value is not given.

The Civil War marked a new era in the making of straw goods, as it did in many other lines of industry. In 1870, the number of establishments in the United States was 75, with *employés* numbering over 14,000, all but about 2,000 being females; Massachusetts had 39 shops, employing 1,113 males, 10,000 females; New York, 18 shops, and 518 males and 886 females; Connecticut, 3 shops, with 225 males, and 735 females. Since that time the business has grown in the places mentioned, and secured a firm footing in other localities, especially in Philadelphia, Baltimore, Chicago, Milwaukee, and the State of New Jersey. There are very few of the places noted as pioneers of in the manufacture of straw goods that do not carry it on to-day, Medway, Mass., being an exception. Holliston, Framingham, and Westboro, Mass., are places not mentioned above, where, especially in the two latter, straw serves as a large and important item in the enterprise and general prosperity.

The output from the New England shops last year is set down at 14,000,000 hats, and from factories west of New England nearly as much more, making in all from 25,000,000 to 30,000,000 hats as the annual production of the country. This, with the large number of hats made over in the repair shops, gives a supply probably equal to a straw hat for every individual in the United States. In the estimates above, however, the velvets and felts which some of the shops make for ladies' wear are included, but men's, except straws, are not taken into account.

ELECTRIC LIGHT AT MIDDLESBROUGH.

Among the industrial establishments thrown open to the members of the Iron and Steel Institute, during their late meeting at Middlesbrough, were upwards of a dozen large ironworks situated on the West Marsh of that town, a piece of land forming an irregular arc, bounded by a siding of the North Eastern Railway as chord upwards of 200 yards long, and the River Tees as periphery. In the virtual centre a station has been put up for supplying all or any of these works with electric light, at a fixed charge per annum.

The first works lighted by the Yorkshire Brush Electric Light and Power Company were those of the North-Eastern Steel Company, which was formed for making steel entirely from phosphoriferous Cleveland pig by the Thomas-Gilchrist process. The light was first shown on 23rd October, 1882, being found very useful in the operation of laying down the heavy plant. Subsequently, the ironworks of Messrs. Jones Bros., B. Samuelson and Son, and Gjers, Mills, and Company, and Watson's Wharf were included. The same company have illuminated the steel works of Bolckow, Vaughan and Co., Limited, Middlesbrough, which are kept going day and night. A 40-light Brush dynamo, driven direct by a three-cylinder Brotherhood engine, supplies forty lamps of 1,000

candles each; while a 10 horse-power Tangye engine drives twelve Siemens continuous-current machines, each one with its arc lamp of 3,000 candle-power, as well as twenty Swan incandescence lamps. At the works of the Darlington Forge Company, whose specialty is the accurate machining of large vessel forgings, which are usually smithed, gas has been entirely superseded by electric light in one half of the large machine shop, that in which turning operations are conducted. Five Siemens dynamos are driven by the existing engine, which also drives the lathes.

An application of secondary batteries to temporary illumination was made by the Hammond Electric Light Company, at Marton Hall, the last day of the Iron and Steel Institute meeting, at a conversazione given by Mr. and Mrs. Carl Bolckow. The conservatories were lighted with twenty-five 20-candle Swan incandescence lamps, supplied by twenty-six Faure-Volckmar storage batteries, that had been charged in London, and sent down by passenger train the previous day. The light was maintained for over three hours, the wires having been laid the same day.

COTTON INDUSTRIES OF SWITZERLAND.

Consul Mason, of Basle, states that there are in Switzerland, according to the most recent statistics, 140 cotton mills, which have an aggregate of 1,854,091 spindles. This is an average of 675 spindles to every 1,000 of the entire population of the country. These mills consume yearly from 100,000 to 120,000 bales of cotton, of which about 3-5ths, or from 60,000 to 80,000 bales, come from the cotton fields of the United States. The cotton manufacture of Switzerland is confined mainly to the north-east cantons, and the oldest cotton mill in Switzerland is at Neue Welt, near Basle, and was established in 1823. The gradual but steady growth of this branch of manufacture will be shown by the importation of raw cotton, which, in 1857, amounted to 22,253,000 lbs., had increased, in 1882, to 51,355,480 lbs. The manufacture of embroideries employs more than 50,000 persons, who produce, annually, goods estimated at a value exceeding £2,500,000; and who receive £1,880,000 in wages. The cotton spinning industry employs 15,000 operatives, who earn about £420,000 annually. Cotton weaving, dyeing, and printing give employment to 17,000 working people, whose aggregate annual earnings are estimated at £382,000. Cotton is also largely used in combination with silk in the manufacture of ribbons by the great ribbon weavers in the district of Basle, who, with a silk warp and a cotton woof, produce not only plain *moire* satin, but also figured ribbons of great beauty and durability. So perfect is this process of weaving, that the cotton is perfectly concealed, and the warp so thoroughly kept on the outside, that the ribbon appears to be wholly made of silk. The raw cotton consumed in Switzerland is purchased at Liverpool, Havre, and Bremen, or imported direct from the United States through the ports of Havre, Rotterdam, Antwerp, and Genoa.

SALT WORKING AT MIDDLESBROUGH.

Among the various works visited by the members of the Iron and Steel Institute during their recent meeting at Middlesbrough, were those for raising and preparing salt, undertaken by Messrs. Bell Brothers, the whole process being explained by Mr. T. Hugh Bell.

Although salt has been obtained by evaporating sea water on the north-east coast for centuries, and local names, such as Saltholme and Salt Beck would appear to prove early knowledge of the presence of salt, the deposit was only discovered in 1862, when Mr. John Vaughan, of Bolckow and Vaughan, bored for water on the south bank of the Tees, for feeding his steam boilers, and struck the salt at a depth of 1,200 feet. The firm subsequently endeavoured to work the deposit by means of a shaft, but soon abandoned it, on account of the heavy cost. In 1874, Messrs. Bell Brothers sank a bore-hole on the north side of the river, and found the salt at a depth of 1,127 feet, or 73 feet nearer the surface. This deposit exists in the paleozoic series overlying the coal measures, and is about 3,000 feet lower, and considerably older, geologically, than the Cheshire salt, which is found entirely in the triassic series of rocks. The theory of its formation is that the salt water, in isolated basins cut off from the sea, or communicating with it by narrow entrances only, was gradually concentrated, until it became saturated. The extent of the bed has not been ascertained; and all that is known at present is that it rises to the north, and dips to the south. The thickness, however, as proved by a second bore-hole put down by Messrs. Bell in 1881, is 65 feet, which warrants the estimate that salt is present under Middlesbrough in the proportion of 200,000 tons to the acre, which is exactly equal to the annual consumption on the Tyne.

In Cheshire, the surface water trickles through the clay to the gypsum, and flows over the salt, which is thus converted into brine, and only requires being raised to the surface; but, in the Middlesbrough deposit, the nature of the strata and the great depth preclude all chance of infiltration. It occurred, however, to Mr. Thomas Bell, that the salt might be raised by allowing fresh water to flow into the hole and become saturated with salt, and then pumping out the brine, without sinking a shaft. The suggestion was quite independent, although this method of working has long been adopted in the east of France. Accordingly, the bore-hole was put down successfully by the rotary diamond drill; and it so happened that a portion of the lowest core was left at the bottom of the hole, leaving an annular space, which has served to receive the lower end of the lining tube. This

latter is perforated with holes where it passes through the salt; and the greater portion of its weight is carried by a ring resting on the surface. An inner tube, perforated for a short distance at the bottom, is supported partly by a plate at the bottom and partly by girders at the top. There is an annular space between the two tubes, into which fresh water is allowed to flow. This water makes its way out through the holes in the outer tube, becomes saturated with salt, and rises in the inner tube, but only to such a level that the two columns bear the proportion of ten to twelve, that being the relation of the specific gravities of brine and water. The pump is, however, placed below this level, so as to avoid the necessity for suction. The pump, worked by an engine at the rate of fourteen strokes a minute, lifts from eight to nine gallons of brine at each stroke. When the cavity in the salt bed at the bottom of the hole has attained a certain size, the following is supposed by Mr. T. Hugh Bell to be what takes place. A molecule of water, descending the annular space between the two tubes, reaches the upper cavity in the salt, and there finds saturated brine. It, therefore, no longer continues its downward course, but floats on the surface of the heavier fluid, having no tendency to sink until it becomes saturated by coming into contact with the undissolved rock salt. The cavity at the bottom is, therefore, filled with a solution of salt, saturated, or nearly so, with fresh water flowing along its surface, and which gradually becomes saturated in turn. The pump draws the saturated solution from the bottom of the hole, and makes room for fresh water on the surface, so that there is a tendency for the hole to become enlarged at the bottom, and assume the form of a very flat inverted funnel.

The brine is pumped into a reservoir containing 500,000 gallons, and, roughly, between 500 and 600 tons of salt, the salometer standing at about 23°. Thence it flows into twelve shallow evaporating pans, nine of which are heated with coal, and three by the waste gases of the blast-furnaces adjoining, the temperature of the brine being kept at 170°. The salt crystallises in regular cubes, which float on the surface; and on each cube is formed others, until the whole mass becomes too heavy to float, and sinks to the bottom. Some difficulty was experienced in a thin pellicle forming on the surface, which prevented the crystals from falling, and also arrested evaporation. This was found, on investigation, to be due to gelatinous vegetable matter, which was present in the surface water used; but upon water from the Darlington Waterworks being substituted, the difficulty ceased. Salt is taken out every other day upon platforms, called "hurdles," between the pans, and conveyed in barrows to railway waggons. A scale of sulphate of lime forms on the bottom of the pan, which requires removing at intervals, and also necessitates the laying off and thorough cleaning of the pan every three or four weeks. The twelve pans produce 360 tons a-week of coarse salt, suitable for curing purposes and for chemical works, table salt requiring to be crystallised at a much higher temperature. The firm are now turning their attention to the utilisation of the brine, as it comes from the bore-hole, for making carbonate of soda. They are also making preparations for putting down another hole, to be ready in the event of the existing one failing, through a fall of the roof, or the tube being destroyed.

THE VINE AND OLIVE IN SIENA.

Consul Colnaghi, writing on the agriculture of Siena, says that too many varieties of vines are cultivated in the province; of late years, however, there has been an improvement, and in new plantations the following qualities predominate:—*San giovese*, *canaiolo* and *mammolo* in black grapes, and trebbiano and malvasia, white grapes. Throughout the province the black qualities known as *gorgotesco* and *prugnolo* are also largely cultivated. The soil of the province being very varied, both topographically and geologically, the method of cultivating the vine differs in the various localities. In some places the vines are attached, or married, to trees, most frequently the *acer campestris*, planted in rows along the fields and pruned, in others, they are grown low, and fastened to stakes. The plantation of vineyards on the French system, instead of growing the vines in the fields with other crops, is on the increase, but generally speaking, the latter method prevails, which accounts for the small yield of wine, as compared with the large area under vine cultivation. The best known wines of Siena are the *chianti*, *montepulciano*, and the *montalcino*. For planting vines in rows in the fields, trenches four feet in breadth by four feet deep are dug, the drainage being effected by means of a layer of stones or of fascines. The trenches are filled in with earth, and planted with slips called *magliuoli*, or layers which have already thrown out roots, at intervals of about two feet for low vines, and of some yards for plants intended to be attached to the trees. These vines are generally pruned in one or two manners, known locally as *a piegatura* or *tralcinata*, and *a penzana* or *catena*. Vines grown low are pruned *a cornetto*. The ground requires to be dug up and hoed every year, and manured every two years, or in some cases lupines are sown and dug in. The vineyards on the French system are dug up in the spring and manured in August. The plants are laid down in ground well broken up, generally to the depth of about four feet, the largest stones in very stony soil being selected for drainage, or to form terrace walls on the steeper hillsides. The olive is cultivated on the hills. In some places it is grown in plantations, and in others the trees are generally planted in rows along the fields, in combination with other cultures. The varieties most generally grown are the *correggiolo*, the *moraiolo*, which ripens early, and the *olivastro*. The trees are grown from slips cut in the spring, which

are planted in holes in ground that has been well broken up and covered with mould, and watered as required. The hardiest shoot is subsequently selected, and may be permanently planted in three years. The olive is also raised from seed. In the districts of Siena, when a tree is about to be cut down, the *ovoli*, or eyes, on the roots are detached, and placed in a separate plot of ground, plants being obtained from them in three years, which can then be transplanted. In the wooded districts where the wild olive is plentiful, grafting is commonly employed. The trees are usually planted in holes or ditches of more than two yards square, and a yard deep, drained with a layer of stones. When the olives are planted in rows in the fields, they are generally pruned *a paneira*, nearly all the inner branches being cut away from the centre to enable air and light to penetrate freely. The trees are pruned every two or three years. The most careful cultivators apply a special manure, when the trees are between five and eight years old, composed of straw, mixed with woollen rags, the whole saturated and moistened with sewage, but this is not general, as the trees profit by the manure laid on the fields. It is estimated that in the Province of Siena, one acre of vines will produce 115 gallons of wine, and an acre of olives 20 gallons of oil; the quantity of the former actually produced in 1882, amounting to 10,898,000 gallons, and of the latter, 780,000 gallons.

General Notes.

Steam Tramways in Sydney.—The statement in the last number of the *Journal*, that the motors for these tramways were principally obtained from America (see *ante*, p. 994), was taken from a paper issued by the Immigration Department of New South Wales. Messrs. Merryweather and Sons write that engines of their make are also working on the Sydney tramways, and that they are considerably lighter than the American locomotives. They state that their engines are noiseless and vapourless, and not liable to frighten the horses in the streets.

Cotton Yarn in France.—A decree of the President of the French Republic for the temporary free admission of cotton yarn into France has been issued, the first article of which is—"Cotton yarns in the grey state (*écrus*), single or double, of number 50 (metric system) and higher, intended for the manufacture of muslins and goods made of silk and cotton, will be able to be admitted free temporarily, under the conditions determined by article 5 of the law of 5th July, 1836." The action of the French Government in this matter has met with considerable objections on the part of the French cotton spinning industry. The Chamber of Commerce at St. Quentin has addressed a petition to the Government, asking for a reconsideration of the question at issue. Importance is attached to the fact of the Superior Council of Commerce and the Chambers of Commerce not having been consulted before the final measures were taken.

Uniformity of Time.—According to a statement of M. Modeste Anquetin, in the *Revue Scientifique*, communications have been taken place between the governments of France and the United States, the latter having invited the former power to a joint discussion of the possibility of establishing a universal time, by selecting a meridian common to all nations. The French Academy of Sciences, feeling the importance of the question (more particularly with reference to its sections of astronomy, geography, and navigation), has, it is said, decided upon sending to this congress representatives of all the sciences interested. Amongst various suggestions in connection with the practical application of this idea, it is mentioned that the simplest way of expressing this universal time would be by using Roman figures, while the civil time would be expressed by Arabic numerals, followed by a large H for the morning hours, and a small one for those of the evening. In fact, the hour would be expressed in a manner similar to that in use among the Russians for designating the old and new style in dates. In the same manner as they say 16/28 June, the railway time tables would say—Arrival at Paris, XXIII/10h. 24m.; departure from Paris, XVI–40m./4h. 04m.; departure from St. Petersburg, VIII–10m./9h. 26m.

Iron Industry of New South Wales.—The existence of extensive deposits of rich iron ores at Wallerawang, Lithgow, Mittagong, Mount Lambie, Berrima, Illawarra, and in various other parts of this colony, has been demonstrated—in many instances in the vicinity of coal and lime in abundance; but, owing to the heavy cost of erecting smelting and other works, and the difficulty of securing the necessary skilled labour, very little has yet been done towards developing this important source of wealth. In fact, with the exception of the Fitzroy Works at Mittagong, which have been abandoned for some time past, the only works in the colony are those of the Eskbank Iron Company, at Lithgow Valley, which were originated in 1875. These works consist of furnace, foundry and forge, and rolling mills; the two branches are connected by a horse tramway. Most of the plant, including a 24-ton fly-wheel, was made on the ground. The blast-furnace is capable of producing 100 tons of gray, or 115 tons of white iron per week. Both pig and malleable iron are made, and large quantities of rails for tramways have been rolled. Upon this Company's property are iron ore, coal, fireclay, and moulders' sand. During the year 1881, the Eskbank Iron Company made pig iron to the value of £10,950; bar, angle, and rail iron to the value of £31,086, and castings, &c., to the value of £5,777. During the year, the blast furnace was worked only five months and seventeen days.

Journal of the Society of Arts.

No. 1,614. Vol. XXXII.

FRIDAY, OCTOBER 26, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

SWINEY PRIZE.

The Council have to give notice that the next award of the Swiney prize will be in January next. Dr. Swiney died in 1844, and in his will he left the sum of £5,000 Consols to the Society of Arts, for the purpose of presenting a prize, every fifth anniversary of the testator's death, to the author of the best published work on Jurisprudence. The prize is a cup value £100, and money to the same amount; the award is made jointly by the Society of Arts and the College of Physicians. The cup now given is made after a design specially prepared in 1849 for the first award, by D. Maclise, R.A. Any person desiring to submit a work in competition, or to recommend any work for the consideration of the judges, should do so by letter addressed to the Secretary of the Society.

The following is a list of recipients :—

1849. J. A. Paris, M.D., and J. Fonblanque, for their work, "Medical Jurisprudence."

1854. Leone Levi, for his work on "The Commercial Law of the World."

1859. Dr. Alfred Swayne Taylor, F.R.S., for his work on "Medical Jurisprudence."

1864. Henry Summer Maine (now K.C.B.), D.C.L., member of the Legislative Council of India, for his work on "Ancient Law."

1869. William Augustus Guy, M.D., for his "Principles of Forensic Medicine."

1874. The Right Hon. Sir Robert Joseph Phillimore, D.C.L., for his "Commentaries on International Law."

1879. Dr. Norman Chevers, for his "Manual of Medical Jurisprudence for India."

Miscellaneous.

NATIVE PRESS OF INDIA.

In March, 1877, I had the honour of reading a paper before the Society of Arts on the "Native Press of India," and I now forward a statement of its progress since that date.

It will be seen that, during the past seven years, the number and circulation of the native Indian newspapers have doubled. This is very satisfactory progress, considering that it is only seven or eight years ago that their existence first began to be observed in England.

On the character of the native press, I wrote, in 1877:—"Considering the rapidity with which it has grown up, and the distinction and influence which the leading native newspapers have gained, it is evident that the native press of India supplies a real want in native society; and the fact of the transparent honesty, although its unnecessary personalities and violence are admitted, with which it deals with felt local grievances, makes it an admirable handmaid to the Government in the administration of the country. Taken as a whole, * * * I scout the idea of its disloyalty as utterly childish and unjust. When there is anything like disloyalty, it has been promoted by the example, or provoked by the taunts, of the Anglo-Indian press."

My further examination of the native press has confirmed me in this opinion. All the more influential and widely circulated papers are conspicuously loyal; and, as a rule, loyalty is the badge of all their tribe. Occasionally there are outbursts, from the smaller fry of them, of what English people often call disloyalty; but for the most part it is purely literary, and in retort on the vituperative assaults of the Anglo-Indian press. The newspaper storm which raged in India, some months ago, over the so-called "Ilbert Bill," is an illustration of this. The native newspapers had then, indeed, a great opportunity for showing self-command, which, I extremely regret to say, they failed to seize; but they are to be excused, if not justified, for the default, by the howl of unprovoked, unmeasured, and indiscriminate abuse with which a section of the Anglo-Indian press was the first to attack, not only the Bill itself, but the whole innumerable rout of nations of the multifarious millions of the people of India, who naturally and frankly approved of it. Since then, however, the official opinions on the Bill have been published in the *Calcutta Gazette* of 8th September last; and although, as counted, they are, for the greater number, opposed to the Bill, yet so temperately and candidly are they expressed, that the exasperation of the native newspapers was at once quelled, and nothing can be fairer in argument, or more loyal in spirit, than the manner in which they now discuss

the Bill; while their opponents are reduced, like the mob of Paris the other day, to a tacit retreat from the truculent front they had assumed—into the silence of their shame—without exhibiting even the grace of an apology generously proffered. I am not expressing an opinion on the Bill, one way or the other, but only on the conduct of the two chief parties, the Native Press of India, and the Anglo-Indian Press, in the late exploded controversy about it.

I take this opportunity of drawing attention to the *Voice of India*, a new Indian Magazine, published every month in Bombay under the editorship of my old friend, Mr. Dadabhai Naoroji. It seeks to reflect with accuracy, impartiality, and completeness, the views of the native press of India on every question of the day in which it is interested. This duty it has so far discharged with successs; and every public man and every publicist in England should subscribe to it. It is on sale in this country at 14, Cockspur-street, Charing-cross, and the subscription to it, including postage, is £1 a year, payable in advance.

GEORGE BIRDWOOD.

22nd October, 1883.

COMPARATIVE STATEMENT OF NATIVE NEWSPAPERS, AND THEIR CIRCULATION, PUBLISHED IN INDIA IN 1877 AND 1883.

The names of papers which have ceased to appear since 1877 are printed in SMALL ROMAN CAPITALS. The names of those which have appeared since 1877 are printed in small *Italic* type. The names of all others are printed in small Roman type.

In the instances in which the circulation has increased or decreased since 1877, the number for that year is printed under the number for 1883, the two numbers being braced together. In the instances in which the circulation is given on my own assumption, the number is placed within brackets.

BOMBAY PRESIDENCY.

Name of Newspaper.	Place of Publication.	Edition.	Number of copies issued.
ENGLISH.			
The Indian Spectator	Bombay	Weekly	450
Mahratta	Poona	,,	475
Morning Star	Ahmedabad	Monthly	450
Quarterly Journal of the Tarvajanik Sabha	Poona	Quarterly	200
ANGLO-MARATHI.			
The Din Bandhu	Bombay	Weekly	1,400
BODHA SUDHAKAR	Satara	,,	275
Dnyan Prakash	Poona	Bi-Weekly	{ 484 / 700
Dnyan Chakshu	,,	Weekly	1,000
Dnyanodaya	Bombay	,,	{ 409 / 325
Indu Prakash	,,	,,	{ 1,038 / 1,200
Native Opinion	,,	,,	{ 575 / 400
Subodh Patrika	,,	,,	600
SURYODAYA	Tanna	,,	375
MAHARASTRA MITRA	Satara	,,	250
Urdu Akhbar	Akola	,,	{ 280* / 160†
MARATHI.			
The Arunodaya	Tanna	Weekly	{ 555 / 410

* Marathi portion. † English portion.

BOMBAY PRESIDENCY.—*(Continued.)*

Name of Newspaper.	Place of Publication.	Edition.	Number of copies issued.
The A'rya Warta	Dhulia	Weekly	100
Aranya Pandit	Bombay	Fortnightly	100
Belgaum Samachar	Belgaum	Weekly	260 to 300
Bakul	Ratnagiri	,,	450
Bhala	Sholapur	,,	200
*Bodh Sudhakar**	Satara	,,	275
Chandrika	Kolhapur	Monthly	150
Chhava	Dharwar	Weekly	200
Dnyan Bodhak	,,	,,	140 to 175
Dharwar Writt	,,	,,	425 to 350
Dnyan Sagar	Kolhapur	,,	116 to 125
Daivadnya Dipika	Bombay	Fortnightly	150
Daivadnya Samachar	,,	,,	500
Ganga Lahari	Nasik	Weekly	100
Hitechchhu	Kaladgi	,,	85 to 125
Hindu Punch	Thana	,,	285 to 340
HUBLI WAIBHAN	Hubli	,,	75
HINDU MITRA	Bombay	Daily	150
*Israel**	,,	Fortnightly	400
Jagan Mitra	Ratnagiri	Weekly	145 to 175
Jagadadarsh	Ahmednagar	,,	185
Kalpataru	Sholapur	,,	130 to 150
Khandesh Waibhar	Dhulia	,,	125
KASHTA WILASINI	Poona	,,	125
KARTNATAK WARTIKA	Belgaum	,,	150
Kartnatak Mitra†	,,	,,	200
Kesari	Poona	,,	3,500
Lamp of Judaism	Bombay	Fortnightly	300
Lokahitaradi	Poona	Monthly	220
MALWAN SAMACHER	Malwan	Weekly	210
Maharashtra Hitechchhu	Bombay	,,	1,000
Maharashtra Mitra	Satara	,,	250
Malika	Poona	Monthly	100
Nyaya Sindhu	Ahmednagar	Weekly	185
Nasik Writt	Nasik	,,	100
Nagar Samachar	Ahmednagar	,,	200 to 150
Nibandh Mala	Poona	Monthly	700
Nibandh Chandrika	,,	,,	200

* Frequently admits English articles. † Certain articles in Kanarese also.

BOMBAY PRESIDENCY.—*(Continued.)*

Name of Newspaper.	Place of Publication.	Edition.	Number of copies issued.
THE PARASHU	Jamkhindi	Weekly	50
PANDHARI WRITT	Pandharpur	,,	150
Panchanan	Malran	,,	800
Pandhari Vaibhar	Pandharpur	,,	103
Poona Vaibhar	Poona	,,	250
*Prabhakar**	Bombay	Daily	350
Prabodh Chandrika	Jalgaon	Weekly	200
Pramod Sindhu	Umrawati	,,	200
Pune Sarvajanik Sabheche Masik Pustak	Poona	Monthly	200
Shubh Suchak	Satara	Weekly	90 85
Satya Sadau	Alibag	,,	400
Satya Shodhak	Ratnagiri	,,	150 140
SUNODHA PATRIKHA	Bombay	,,	1,600
Shiwaji*	Poona	,,	200
Swadesh Mitra	Bombay	Daily	600
SAUMARGA DARSHAK	Mudhol	Weekly	600 120
Saddharm Dip	Alibag	Monthly	600
Satya Prakash	Bombay	Fortnightly	243
Satyavadi	,,	,,	275
Sharabh	Alibag	Weekly	200
Srishtidarpan	Bombay	,,	200
Suryakant	Ellichpur	,,	150
Suryodaya	Thana	,,	240
Sradesh Hitechchhu	Bombay	,,	150
*Varhad (Berar) Samachar**	Akola	,,	250
Vartahar	Bombay	,,	200
Vasai (Bassein) Samachar	Bassein	,,	175
Vengurla Vritt	Vengurla	,,	200
Vicharshil	Malwan	,,	300
Vinod	Poona	,,	200
Vividh Dnyan Vistar	Bombay	Monthly	400
ANGLO-GUJARATI.			
The Bombay Chronicle	Bombay	Weekly	200
Gujarat Mitra	Surat	,,	400
Hitechchhu	Ahmedabad	,,	349 450
Lok Mitra	Bombay	,,	800
Surya Prakash	Surat	,,	137 200
Surat Akhbar	,,	,,	600
GUJARATI.			
The Akhbare Sowdagar	Bombay	Daily	750 615

* Frequently admits English articles.

BOMBAY PRESIDENCY.—*(Continued.)*

Name of Newspaper.	Place of Publication.	Edition.	Number of copies issued.
THE A'RYA MITRA	Bombay	Weekly	250
Ahmedabad Samachar	Ahmedabad	,,	25 60
ADAL INSAF	Mahadha	,,	61
A'rya Dharm Prakash	Bombay	Monthly	303
A'rya Dnyan Vardhak	,,	,,	500
Bombay Samachar	Bombay	Daily	1,090 700
Broach Wartaman	Broach	Weekly	60 50
Bombay Punch	Bombay	,,	500
Broach Samachar	Broach	,,	700
Buddhi Prakash	Ahmedabad	Monthly	600
Deshi Mitra	Surat	Weekly	1,000 900
DUNIADAD	Nadiad	,,	125
DATARDUM	Bombay	,,	1,000
Dnyan Dipak	Junagad	Monthly	100
Dnyan Prasarak	Ahmedabad	,,	200
Dnyan Vardhak	Bombay	,,	400
Fursad	,,	,,	100
Gujarati	,,	Weekly	400
Gujarati Monthly Journal	,,	Monthly	200
Gul Afshan	,,	,,	650
Hitopadeshak Ratna	Ahmedabad	,,	200
Jame Jamshed	Bombay	Daily	525
Kira Wartaman	Kaira	Weekly	115 153
KATTWAR SAMACHAR	Rajkot	,,	45
Kaira Khetiwardi Patra	Nadiad	Monthly	1,400
Kaiser-i-Hind	Bombay	Weekly	200
Kaside Mumbai	,,	Tri-Weekly	700
Kusum Guchchra	Ahmedabad	Monthly	350
Niti Prakash	Kaira	Weekly	200 115
Nagar Udaya	Ahmedabad	Monthly	300
Nure Elam	Bombay	,,	381
Nyaya Prakash	Surat	Weekly	200
Parsi Punch	Bombay	,,	1,225 225
PANCH DAND	,,	,,	700
Rast Goftar	,,	,,	814 1,650
SIND SAMACHAR	Kurrachee	Weekly	60
Samsher Bahadur	Ahmedabad	,,	200
Satya Mitra	Bombay	,,	400
Saurashtra Darpan	Junagad	Monthly	200
Stri Bodh	Bombay	,,	533
Subodh Prakash	Nadiad	,,	200

BOMBAY PRESIDENCY.—*(Continued.)*

Name of Newspaper.	Place of Publication.	Edition.	Number of copies issued.
The Sradesh Vatsal	Bombay	Monthly	408
Tatota Dnyan ane Dakor Samachar	Umreth	Fortnightly	62
Trimasik Tikakar	Limbdi	Quarterly	200
Umreth Samachar	Umreth	Weekly	53
Vartaman Sar	Surat	,,	200
Vidnyan Vilas	Rajkot	Monthly	738
Vidya Mitra	Bombay	,,	300
Yajdan Parast	,,	Weekly	500
KANARESE.			
The Chandrodaya	Dharwar	Weekly	150
Karnatta Writt	Belgaum	,,	200
URDU.			
The Abuz Zurfeh	Bombay	Weekly	200
Altaf	,,	,,	200
Armagan	,,	,,	200
Dabdabe Islam	,,	,,	200
Khadam-i-Hind	,,	Daily	200
Khayirkham-e-Islam	,,	Tri-Monthly	300
Kushful Akhbar	,,	Weekly	160 175
Muzhire Shawkatul Islam	,,	,,	200
PERSIAN.			
The Mufarrehul Kulub	Karachi	Weekly	300

SUMMARY.

Languages.	1877.		1883.		Increase since 1877.	
	Number of Newspapers.	Circulation.	Number of Newspapers.	Circulation.	Number of Newspapers.	Circulation.
English	nil	nil	5	1,575	5	1,575
Anglo-Marathi	8	4,525	9	5,946	1	1,421
Marathi	29	7,065	60	19,357	31	12,292
Anglo-Gujarati	3	1,050	6	2,486	3	1,436
Gujarati	21	8,219	44	17,589	23	9,370
Kanarese	nil	nil	2	350	2	350
Urdu	1	175	9	1,660	8	1,485
Persian	1	300	1	300	..	..
Total	63	21,334	136	49,263	73	27,929

THE NORTH-WEST PROVINCES, THE PUNJAB, OUDH, AND THE CENTRAL PROVINCES.

Name of Newspaper.	Place of Publication	Edition.	Number of copies issued.
URDU.			
ATALIK-I-HIND	Lahore	..	..
ANJUMAN AKHBAR	Shahjanpur	..	..
Agra Akhbar	Agra	Weekly	196
Anwar-ul-Akbar	Lucknow	,,	230
Akmal-ul-Akbar	Delhi	,,	84
Akhbar-i-Am	Lahore	Bi-Weekly	1,800
Akhbar-i-Alam	Meerut	Weekly	100
ASAR-UL-AMSAR	Lucknow	..	..
Akbar-i-Anjuman-i-Panjab	Lahore	,,	425
Akbar-i-Anjuman-i-Hind	Lucknow	,,	141
Aftab-i-Hind	Jalandhar	,,	150
Aftab-i-Panjab	Lahore	Tri-Weekly	500
Aina-i-Sikandari	Moradabad	Weekly	80
Ainul Akhbar	,,	,,	134
Akhbar-i-Tamannai	Lucknow	,,	125
Akhbaru-l-Akhyar	,,	Bi-Monthly	..
Anjuman-i-Badaun	Badaun	Monthly	175
Ahsanu-l-Akhbar	Amroha	Weekly	84
Aina-i-Tahzib	Saidpur	,,	250
Ashrafu-l-Akhbar	Delhi	Tri-Monthly	110
Dabdaba-i-Sikandari	Rampur	Weekly	390
Dabdaba-i-Qnaisari	Bareilly	,,	200
Dabiru-l-Mulk	Bhopal	Bi-Monthly	349
Desh Upkarak	Lahore	Weekly	700
Dharam Jiwan	,,	Monthly	150
Delhi Punch	,,	Weekly	310
Fitnah	Gorakhpur	Weekly	..
Growse Gazette	Bulandshahr	,,	40
HADI-I-HAKIKAT	Lahore	..	..
HINDU PRAKASH	Amritsar	..	..
Hami-i-Hind	Cawnpore	Weekly	..
Islam	Meerut	,,	330
Jalwa-i-Tur	,,	,,	90
Jam-i-Jamshed	Moradabad	,,	125
Karnamah	Lucknow	,,	250
Khair Khwah-i-Alam	Delhi	,,	140
Khair Khwah-i-Panjab	Gujranwala	,,	600
Koh-i-nur	Lahore	Bi-weekly	450
KURSHID-I-JAHANTAB	Agra	..	..
Khair Khwah-i-Hind	Delhi	Bi-Monthly	180
Katehar Punch	Badaun	Tri-Monthly	50
Kankab-i-Hind	Lucknow	Bi-Monthly	416
Kayasth Samachar	Allahabad	Monthly	177
Lama-i-Nur	Jaunpur	Weekly	72
LAGH-I-MAHFUZ	Moradabad	..	..

THE NORTH-WEST PROVINCES.—*(Continued.)*

Name of Newspaper.	Place of Publication.	Edition.	Number of copies issued.
Lawrence Gazette	Meerut	Weekly	165
Lyall Gazette	,,	,,	..
Lytton Gazette	Delhi	Bi-Monthly	300
Maksud-ul-Akhbar	Gurgaon	..	..
Mufid-i-Am	Agra	Tri-Monthly	100
Matla-i-Nur	Cawnpore	Weekly	40
MANGAL SAMACHAR	Beswan	..	..
MUHIBB-I-HIND	Meerut	..	..
MEERUT GAZETTE	,,	..	..
MAYO MEMORIAL GAZETTE	Delhi	..	..
MAKSUD-UL-AKHBAR	Gurgaon	..	..
Muir Gazette	Meerut	Weekly	..
Mashir-i-Qaisar	Lucknow	,,	200
Mihr-i-Darakhshan	Delhi	,,	100
Mihr-i-Nimroz	Bignor	,,	140
Mumtazu-l-Akhbar	Barabanki	,,	160
Meerut Akhbar	Meerut	,,	180
Murasla-i-Kashmir	Lucknow	Monthly	500
Murrqqa-i-Tahzib	,,	Bi-Monthly	150
NASIM-I-JAUNPUR	Jaunpur	..	..
NAJM-UL-AKHBAR	Meerut	..	..
Nur Afshan	Ludhiana	Weekly	750
Nur-ul-Anwar	Cawnpore	,,	340
Naiyar-i-Agim	Moradabad	,,	175
Najmu-l-Akhbar	Etawah	,,	150
Najm-ul-Hind	Moradabad	,,	150
Nasim-i-Hind	Fatehpur	,,	92
Nur-i-Badaun	Badaun	,,	250
Nusratu-l.Akhbar	Delhi	,,	200
Nasim-i-Agra	Agra	,,	325
Nuru-l-Absar	Allahabad	Bi-Monthly	120
Oudh Akhbar	Lucknow	Daily	610
Oudh Punch	,,	Weekly	450
Patiala Akhbur	Patiala	,,	300
Panjabi Akhbar	Lahore	Bi-Weekly	250
Panjab Punch	,,	,,	160
Prince of Wales' Gazette	Meerut	,,	70
Qaisari Akhbar	Julandhar	Weekly	..
ROHILKHAND AKHBAR	Moradabad	..	..
ROZNAMCHA	Lucknow	..	..
Rafah-i-Am	Sialkot	Weekly	600
RAJPUTANA SOCIAL SCIENCE CONGRESS GAZETTE	Jaipur	..	..
Rahbar-i-Hind	Lahore	Bi-Weekly	450
Reformer	Lahore	Weekly	700
Riyazu-l-Akhbar	Gorahkpur	,,	275
Rekhti Akhbar	Delhi	Bi-Monthly	184
Shula-i-Tur	Cawnpore	Weekly	175
Sadik-ul-Akhbar	Bhawalpur	,,	320
SAIYID-UL-AKHBAR	Delhi	..	..

THE NORTH-WEST PROVINCES.—(*Continued.*)

Name of Newspaper.	Place of Publication.	Edition.	Number of copies issued.
Safir-i-Hind	Delhi	Bi-Monthly	300
Sabha Kapurthala	Kapurthala	Weekly	120
TAJ-AL-AKHBAR	Lucknow	..	..
TAHZIB-UL-AKHLAQ	Aligarh		..
Tahzib	Moradabad	Weekly	90
Tahzibu-l-Asar	Sitapur	Monthly	500
Tibyanu-l-Akhbar	Lucknow	Bi-Monthly	110
Tutiya-i-Hind	Meerut	Weekly	150
URDU AKHBAR	Delhi	..	..
URDU DELHI GAZETTE	Agra	..	..
VIDYA VILAS	Jammu	..	..
VAHIL-I-HINDUSTAN	Amritsar	..	..
Victoria Paper	Sialkot	Daily	600
Waqaya-i-Alam	Ghazipur	Weekly	300
URDU ENGLISH.			
Aligarh Institute Gazette	Aligarh	Bi-Weekly	295
Public Opinion	Benares	Weekly	100
HINDI.			
Almora Akhbar	Almora	Weekly	98
BENARES AKHBAR	Benares		200
Bharatendu	Brindaban	Monthly	250
Bharati Vilas	Agra	Tri-Monthly	150
Brahman	Cawnpore	Monthly	400
Gyan Pradyini Patrika	Lahore	,,	160
Hindi Pradip	Allahabad	,,	220
Kavi Vachan Sudha	Benares	Weekly	350
Mittra Vilas	Lahore	,,	250
Prayag Samachar	Allahabad	,,	700
Sajjan Kirti Sudhakar	Udaipur	,,	200
HINDI-URDU.			
Arya Darpan	Shajahanpur	Bi-Monthly	440
GWALIOR GAZETTE	Gwalior		225
Hindustani	Lucknow	Bi-Weekly	
Jaipur Gazette	Jaipur	,,	200
Kashi Pattrika	Benares	Weekly	600
Marwar Gazette	Jodhpur	,,	100
Municipal Guide	Agra	Monthly	75
Ratu Prakash	Ratlam	Weekly	400
Sattyah Prakash	Bareilly	Monthly	400
HINDI-ENGLISH.			
Bharat Bandhu	Aligarh	Weekly	135
GURUMKHI.			
Gurumkhi Akhbar	Lahore	Weekly	..
MARATHI-ENGLISH.			
Nyaya-Sudha	Harda	Weekly	400

NORTH-WEST PROVINCES.—*(Continued.)*

Name of Newspaper.	Place of Publication.	Edition.	Number of copies issued.
MARATHI.			
Malwa Akhbar	Indaur	..	
Vritt Dhara	Dhar	Weekly	135
BENGALI.			
Sahas	Allahabad	..	300
ARABIC.			
NAF-UL-AZIM	Lahore	..	..

SUMMARY.

Language.	1877.		1883.		Increase since 1877.	
	Number of Newspapers.	Circulation.	Number of Newspapers.	Circulation.	Number of Newspapers.	Circulation.
Urdu	57	10,538	83	21,016	26	10,478
Urdu-English	1	295	3	395	1	100
Hindi	1	200	10	2,778	9	2,578
Hindi-Urdu	1	225	8	2,175	7	1,950
Hindi-English	nil	nil	1	135	1	135
Gurumkhi	nil	nil	1	100	1	100
Marathi-English	nil	nil	1	400	1	400
Marathi	1	135	2	285	1	150
Bengali	nil	nil	1	300	1	300
Arabic	1	100	..	..	..	..
Total	62	11,493	109	27,584	48	16,091

BENGAL PRESIDENCY.

Name of Newspaper.	Place of Publication.	Edition.	Number of copies issued.
BENGALI.			
Ananda Bazar Patrika	Calcutta	Weekly	700
Arya Darpan	,,	,,	[200]
AMRITA BAZAAR PATRIKA	...	...	2,217
Bharat Shramajivi	Calcutta	Monthly	2,100 650
BURDWAN PRACHRIKA	...	...	[200]
BISHWA SUHRID	...	..	450

BENGAL PRESIDENCY.—(*Continued.*)

Name of Newspaper.	Place of Publication.	Edition.	Number of copies issued.
Bharat Mihir	Mymensing	Weekly	{ 671 / 650
Bharat Hitaishi	Burrisal	Fortnightly	[200]
Bangabasi	Calcutta	Weekly	[250]
Banga Vidya Prakashika	,,	Daily	500
Bartabaha	Pubna	Weekly	[150]
Bharat Bandhu	Calcutta	,,	[200]
Bengal Advertiser	,,	,,	2,000
Burdwan Sanjivani	Burdwan	,,	200
Charuvarta	Sherepore	,,	[150]
Dacca Prakash	Dacca	,,	{ 350 / 400
Dut	Calcutta	,,	[150]
Education Gazette	Hooghly	,,	{ 745 / 1,168
Gramvartra Prakashika	Comercolly	,,	200
Halisahar Prakashika	Calcutta	,,	[200]
Hindu Ranjika	Beauleah	,,	200
HINDU HITOISHINI	...	...	300
HOWRAH HITARKARI	...	...	300
Jatiya Suhrid	Calcutta	Weekly	[700]
Medini	Midnapore	,,	[200]
Murshidabad Patrika	Berhampore	,,	487
Murshidabad Pratinidhi	,,	,,	[200]
Navavibhakar	Calcutta	,,	850
Purva Pratidhwani	Chittagong	Fortnightly	[150]
Prem Pracharini	Nawabgunge	,,	[200]
Paridarshak	Sylhet	Weekly	[200]
Pratikar	Berhampore	Weekly	{ 275 / 235
Praja Bandhu	Chandernagore	,,	[200]
Pratinidhi	Calcutta	,,	[200]
Prabhati	,,	Daily	[50]
Rungpore Dik Prakash	Rungpore	Weekly	250
Rajshayhye Samved	Beauleah	,,	[150]
SOMAJ DARPAN	...	...	400
Sadharani	Chinsurah	Weekly	{ 500 / 510
Sansodhini	Chittagong	Fortnightly	600
Som Prakash	Changripotta	...	—
...	24 Pergunnahs	Weekly	{ 700 / 700
Sulabha Samachar	Calcutta	,,	{ 4,000 / 3,000
SAMBHAD BHASKAR	...	...	[150]
Samachar Chandrika	Calcutta	Daily	625
Samrad Prabhakar	,,	,,	700
Samrad Purnachandrodaya	,,	,,	300
Sahachar	,,	Weekly	500

BENGAL PRESIDENCY.—(*Continued.*)

Name of Newspaper.	Place of Publication.	Edition.	Number of copies issued.
Samaya	Calcutta	Weekly	[300]
Sanjivani	,,	,,	[200]
Saraswat Patra	Dacca	,,	[200]
Sudhakar	Mymensing	,,	[200]
Srihatta Prakash	Sylhet	,,	440
Surabhi	Deoghur	,,	[150]
Samachar Sudhabarsan	Calcutta	Daily	[50]
Tripura Vartavaha	Comillah	Fortnightly	100
ENGLISH AND URDU.			
Urdu Guide	Calcutta	Weekly	365 / 400
HINDI.			
BEHAR BANHU	...	...	[200]
Bharat Mitra	Calcutta	Weekly	500
Kshatriya Patrika	Patna	Monthly	[150]
Sar Sudhamdhi	Calcutta	Weekly	200
Uchit Bakta	,,	,,	[150]
PERSIAN.			
Jam-Jahan-numa	Calcutta	Weekly	250
URDU.			
Akhbari-i-Darussaltanat	Calcutta	Weekly	[200]
Amir-ul-Akhbar	,,	Bi-Weekly	[200]
QAZID	...	...	[200]
ASSAMESE.			
Assam Vilasini	Sibsagar	Monthly	[100]
URIYA.			
Balasore Samvad Vahika	Balasore	Weekly	125
Mayurbhunj Pakshik Patrika	Mayurbhunj	Fortnightly	[100]
Purusottam Patrika	Pooree	Weekly	[200]
Utkal Dipika	Cuttack	,,	200
Utkal Darpan	Balasore	,,	160
ENGLISH.			
HINDU PATRIOT	...	.	[100]

BENGAL PRESIDENCY.—*(Continued.)*

SUMMARY.

Languages.	1877.		1883.		Increase since 1877.	
	Number of Newspapers.	Circulation.	Number of Newspapers.	Circulation.	Number of Newspapers.	Circulation.
Bengali	21	16,568	47	22,339	26	5,771
English and Urdu....	1	400	1	365	..	..
Hindu	1	200	4	1,000	3	800
Persian	1	250	1	250	..	..
Urdu	1	200	2	600	1	400
Assamere	nil	nil	1	100	1	100
Uriqa	nil	nil	5	785	5	785
English	1	100	..	..	..	..
Total	26	17,718	61	25,439	36	7,656

MADRAS PRESIDENCY.

Name of Newspaper.	Place of Publication.	Edition.	Number of copies issued.
TAMIL.			
AMIRTAVASANI	...	...	[250]
DINUVARTAMANI	...	...	[200]
Dravidavartamani	Madras	Bi-Weekly	784
Janavinodini	,, ...	Monthly	350
Kalanidhi	Coimbatore	Bi-Monthly	200
Kalaganita	Madras	Tri-Weekly	300
Sathyavartamani	Pasumalai	Bi-Monthly	720
Swadesabhimani	Madras	Weekly	400
Swadesmitra	,, ...	,, ...	1,500
Tatvavivechini	,, ...	,, ...	350
Travancore Abhimani	Nagercoil	Tri-Monthly	300
Veltrikodiyon	Madras	Weekly	250
TELUGU.			
ANDHKRABHASHA SANJIVANI	...	...	[125]
BRAHMANDA RANJANI	...	...	[125]
LOKARANJANI	...	...	[125]
Purusharthapradayini	Masulipatam	Monthly	206
Prabandhakalpavalli	Peddapore	,, ...	172
SUDHI RANJANI	...	...	[125]
Sri Nyayadarsani	Vizagapatam	Bi-Monthly	[125]

BENGAL PRESIDENCY.—*(Continued.)*

Name of Newspaper.	Place of Publication.	Edition.	Number of copies. issued.
Srimun Manorayani	Tuni	Monthly	200
Sri Gayathree	Chicacole	,,	100
Sri Sujanapromdini	Meranji	,,	[125]
The Observer (English)	Visagapatam	Bi-Monthly	125
VIVEKAVARDHANI	Rajahmundry	Weekly	300
ENGLISH.			
NATIVE PUBLIC OPINION	...	...	...
MALAYAN.			
Kirtala Mitram	Cochin	Tri-Monthly	200
PASCHIMA TARAKA			
HINDUSTANI.			
Ahsan-ul-Jaraid	Triplicane, Jam Bazaar, Madras...	...	80
Jarida-i-Rozgar	Triplicane, Roya-pettah, Madras ...	...	450
MAZHAR-UL-AKHBAR	...	...	[150]
Mazhar-ul-Ajaib	Triplicane, Jam Bazaar, Madras...	...	400
MIRAT-UL-ARA	...	...	[150]
Shams-ul-Akhbar	Triplicane, Jam Bazaar, Madras...	...	200
Shahi Umdat-ul-Akhbar	Triplicane	...	250
SAFIR-I-MADRAS	...	...	[150]
SAYYID-UL-AKHBAR	...	...	[150]
Tilism-i-Hairat	Triplicane	...	250

SUMMARY.

Languages.	1877.		1883.		Increase since 1877.	
	Number of Newspapers.	Circulation.	Number of Newspapers.	Circulation.	Number of Newspapers.	Circulation.
Tamil	4	1,276	10	5,220	6	3,944
Telegu	6	1,006	7	1,053	1	47
English	1	150	..	..	..	..
Malayan	1	150	1	200	..	50
Hindustani	7	1,300	6	1,630	1	330
Total	19	3,882	24	8,103	5	4,371

GRAND SUMMARY.

Presidency, &c.	1877.		1883.		Increase since 1877.	
	Number of Newspapers.	Circulation.	Number of Newspapers.	Circulation.	Number of Newspapers.	Circulation.
Bombay.....	63	21,334	136	49,263	73	27,929
North-West Provinces, Oudh, and Central Provinces	62	11,493	109	27,584	48	16,091
Madras	19	3,882	24	8,103	5	4,371
Bengal	26	17,718	61	25,439	36	7,696
Grand Total ..	170	54,427	330	110,389	162	56,047

WATCH MANUFACTURE IN ENGLAND.

The summary recently given by the *Times* Geneva correspondent of the progress of the watch trade in Switzerland may be usefully followed by some account of the present position of the same industry in England. The extent of the English watch trade is broadly indicated by the watch-cases marked at Goldsmiths'-hall and the assay offices at Birmingham and Chester. A deduction has to be made for cases and movements of foreign origin, but some materials for this discrimination are available. In 1880, the latest year for which complete returns have been published, the total number of watches hall-marked was 206,000. The proportion of foreign cases, and of movements cased in England, included in these returns, cannot be estimated at less than 25,000. At Chester, where a distinguishing record has been kept, the foreign cases have averaged 13,000 per annum. Making the allowance required by these considerations, the total annual production of watches in England cannot be estimated at more than 180,000. If we contrast with this the fact that, in 1796, 191,700 watches were marked in Goldsmiths'-hall alone (complete returns for the whole country cannot now be obtained), it will be seen that the industry, viewed relatively to increase of population, and general commercial expansion, has been suffering from distinct atrophy.

Side by side with this fact must be noted the creation of the American watch trade, which within thirty years has probably attained three times the proportions of the English trade; the growth of Besançon, which has placed France among the most important watch-producing nations; and the immense development of the art in Switzerland. The English trade has now no pretensions to occupying the home market. English watch manufacturers find their most profitable business in the colonies; 100 years ago they probably did not export 5 per cent. of their goods; the proportion is now about 50 per cent. At the same time the demand for watches at home has by no means slackened, but has kept pace with our national prosperity. This demand has been met and stimulated by the foreigner, and above all, by the Swiss, who are the great makers of watches for the million, and therefore the great makers of cheap watches. The tendency in the price of English watches is, nevertheless, downwards. Since 1870, the form in which the trade returns have been recorded does not admit of a comparison on this head, but the figures of previous years show that the average price of English watches exported fell from £6·76 in 1867 to £4·76 in 1870. There is no reason to believe that this tendency has been arrested, and on its development the future of the English watch trade largely depends. This condition is not inconsistent with the production of high-priced watches of superior quality; but it requires that the wants of unambitious buyers shall also be met. In this field foreign manufacturers, and notably the Swiss, have a practical monopoly. During the past five years, our total importation of foreign watches (excluding foreign imports re-exported) has fluctuated between £400,000 and £500,000. In 1867, the import was only £180,000. Taking the four years from 1867 to 1870—*data* for a later survey are wanting—Mr. Edward Rigg, of the Royal Mint, has shown that the mean price of foreign watches imported for English consumption was £1·60; the average price of foreign watches re-exported was £2·86. The latter estimate compares most fitly with the average price of the exported English watch, which, for the same period, has been calculated at £5·41. English manufacturers would do well to consider whether this marked difference in price is justified by a corresponding difference in quality.

The causes that retard the development of English watchmaking may be traced to defective organisation and defective appliances. The method of manufacture and the tools employed are not substantially different from the method and the tools of 100 years ago. It is a natural consequence that the trade has shown no elasticity, and that in latter years it has

found little custom at home. English watches are not made in sufficient quantities to justify the production on a large scale of any one particular type; the trade is for the most part in the hands of "small men," who make certain sizes in dozens and half-dozens. In the Swiss and American factories a particular type, if it be considered worth making, is made by thousands; everything is organised for production on a large scale. Confining the contrast to English and American methods, the principal point upon which it is necessary to insist is that in America the 12 or 14 trades which constitute watchmaking are aggregated under one roof and form one compact organisation. By the older method still pursued in England, and until recently almost the rule in Switzerland, the different parts are transported from one workshop to another, in different quarters of the town, and even from one part of the country to another. Under the new method the *maximum* of efficiency and individual responsibility is obtained by the minute subdivision of every process; the loss of time in the transfer from one department to another is so minimised as to be practically non-existent. In the United States, one company alone employs a capital of £400,000, and, with 2,300 hands, produces 200,000 annually—an output equal to the entire English trade. There are no official returns of Swiss manufacture, but the best authorities estimate its growth, during the past five years, at 1,000,000 watches; the total standing to-day at 3,500,000. Besançon, the centre of the French trade, shows an equally remarkable progress. During the five years 1845-9, the average annual production of watches in France was 47,800; it now exceeds half a million. About 90 per cent. of the watches made in France come from Besançon.

It may be taken that an expenditure of £50,000 is scarcely sufficient to aggregate the different branches of watchmaking under one roof, and to supply the new and improved appliances which, during the last fifty years, have been brought to bear upon the art. It would be mockery to tell a small and struggling tradesman that he must organise his business, and make a hundred watches instead of one; combination is the only conceivable means by which, in the majority of cases, so radical a change could be effected. To this solution, the jealousies and isolation of small manufacturers, their conservative instincts, and love of independence, present obstacles that may be regarded as practically insurmountable. In the United States the capital required for associated enterprise has been easily found, because the field had not been previously occupied, and no trade traditions stood in the way.

If this were the conclusion of the whole matter, the prospect would be hopeless indeed. Fortunately, efforts are being made in England to cope with the situation. A plant of machinery for the manufacture of the keyless type of watch has in recent years been put down in Birmingham for the production of both key-winding and keyless watches; a second firm in Birmingham is working an organisation for the production of the ordinary English watch in demand in the colonies; and in Coventry, modern treatment has been grafted on an old-established business, and is working side by side with old methods of manufacture. The financial results of such new enterprises may not at first be wholly satisfactory. In American watchmaking much money has been lost; out of a dozen companies four only can be considered prosperous; while, so far as the original shareholders are concerned, several companies have ceased to exist. The experience thus gained, though not directly profitable to those who have borne the cost, has added to the general stock of knowledge; and, putting aside special impediments—the chief of which may be said to be the existence of a large number of manufacturers with limited means—the necessary transition might be accomplished in this country in much more favourable circumstances than attended the planting of the industry in the United States.—*Times*.

NON-POISONOUS WHITE LEAD.

Many attempts have been made to substitute for carbonate of lead—the ordinary poisonous white lead, that slowly but surely induces paralysis in those who come in contact with it for any considerable period—some less deleterious pigment. Zinc white has often been put forward as a substitute, and is indeed largely employed; but it is open to the objection of not possessing sufficient body or opacity. Sulphate of lead is not poisonous; but, when prepared in the ordinary way by precipitation, is of a crystalline nature, and, therefore, wanting in both these qualities.

A sulphate of lead has, however, been produced by Mr. John T. Lewis, of Philadelphia, by sublimation, which, when treated by the Freeman process, is stated to possess a body and colour superior to the best white lead made by the ordinary process, with the additional merit of being cheaper, while it is also non-poisonous.

In the smelting of lead ore into pig lead, 15 per cent. goes off in fumes, and 10 per cent. are all that it has hitherto been found possible to recover; by this process, however, the whole 15 per cent. are recovered. The sulphate may also be produced from a low quality of galena, or lead ore, which is not suited for smelting into metallic lead, and from the slag formed in the process of smelting.

The plant consists of simple subliming furnaces, iron cooling pipes, suction fans, and a series of flannel or calico bags, arranged vertically in a building well ventilated, so as to allow the filtered gases to escape, leaving behind the sublimed white lead, which is then merely shaken down from the bags into barrels placed beneath them. The manufacture is carried on at

Joplin, Missouri, with four subliming furnaces, about 500 feet of cooling pipes and towers, with suction fans, which drive the fumes into 300 bags, 20 inches in diameter, and 38 feet long, arranged vertically. About 50 tons weekly of white lead are now being produced from waste fumes, slag, and poor ore, by this establishment alone, at a cost not exceeding that given in the following figures :—

	£	s	d
20 cwts. of galena (with 82 per cent. of ore)	8	0	0
Cost of subliming and catching, including repairs, labour, and all expenses	1	10	0
Casks	0	6	0
	£9	16	0

Freeman's process consists of grinding together, in a dry state, under great pressure, and consequently with great friction, sulphate of lead and sulphate of zinc. While neither of these two substances alone possesses good body or opacity, when treated by this process they are so changed in character, that the new substance is stated to be superior in these respects to the best form of ordinary white lead.

The white lead thus obtained mixes well with oil, and has also the advantage of not becoming blackened when exposed to the fumes of sulphuretted hydrogen, and of not peeling off in a saline atmosphere. As a basis for coloured paints, it is recommended on the ground that, being decomposed with greater difficulty, it can be mixed with almost any colouring substance ; and, being free from acid, it does not change the tints of other substances.

ENSILAGE.

Professor Thorold Rogers, whose paper on Ensilage, read last Session, will be remembered by the members, writes as follows on this subject to the *Times* :—

"A good many persons have been making experiments on ensilage during the past year. But nearly all have tried it with a view to seeing whether green forage would keep sound in an airtight and watertight pit, duly weighted on the surface, in default of being absolutely closed. That it would keep under such conditions ought to have gone without asking.

"What ensilage does is to (1) increase the nutritive powers of green forage; (2) to obviate waste ; (3) to save time ; (4) to increase the productive powers of the soil. It does the first, if in no other way, by making the forage more digestible ; the second, by saving a deterioration by exposure to weather; the third, by putting the least possible time between cutting and storing; the fourth, as a sequence of the third, by enabling the farmer to cut a double crop yearly, by giving him opportunity for enlarging his stock of cattle, and by enormously increasing the amount and value of manure.

"I know from the correspondence which I have had (at one time nearly that of a department in a Government office), that the construction of silos is going on on the new plan practised in the United States, and sketched in my little book on the subject, in India and Australia as well as generally in Europe. A day or two ago I gave leave to a correspondent to translate my book on ensilage into Swedish.

"Most English silos of which I have read are made in too shallow masonry. It stands to reason that this increases the expense per cubic yard. They should be from 20 to 25 feet deep, if they are to be made in the cheapest way. I believe that my friend, Mr. Samuel Whitbread, has made the best hitherto constructed in England.

"The main object of ensilage is to get two crops a-year off the same land. Silos are profitable if they obviate loss ; most gainful when they increase produce. I should add, however, that cattle need cleanliness and ventilation as much as human beings do, and I do not wonder at disease being prevalent in English herds, and for the matter of that in flocks, when I see the dark, filthy dens in which they are generally housed, and the wasteful way in which they are exposed to weather. Our forefathers kept their sheep under cover from November to April.

"Had silos been common in England, millions of pounds worth of fodder would have been saved last summer, and not much less worth of aftermath would be saved now. I should have thought that this was the time in which English agriculture could not afford to neglect small economies, let alone great ones."

Notes on Books.

ELECTRICITY AS A MOTIVE POWER. By Count Th. Du Moncel and Frank Geraldy. Translated by C. J. Wharton. London: E. and F. N. Spon. 1883.

The object of this treatise is to give a full account of the various attempts, successful and unsuccessful, which have been made to utilise electricity for the generation, application, and transmission of motive power. It consists of two parts, with an introduction. The introduction deals with general principles, the construction of electro-motors, the various descriptions of electro-magnets, and the like. The first part deals with the "First Phase of Electro-motors," the second, with the "Second Phase." Such is the division of the material. In Part I. we find the earlier history of the subject, and the various attempts to work electro-motors by battery-power are described. The celebrated machine of Jacobi (1838) and the less well known one of his contemporary Davidson (1839), those of Wheatstone, of Elias (the predecessor of Pacinotti, who was the predecessor of Gramme), of

Page (announced with a flourish of trumpets quite equal to that which heralds inventions of our years), of Hjorth, down to those of Froment, are all elaborately described. We even find Lenoir's gas-engine classified as an electro-chemical motor, because the spark from an induction coil was used to fire the explosive mixture of gas and air The second "phase" commences with the discovery of the reversibility of the dynamo. Beginning with chapters on "reversible machines" and on "modern motors," we come next to an account of the principal small motors, those of Griscom, Cuttriss, Burgin, Jablochkoff, Trouvé and others; while the chapters following describe in detail the special applications of electrical power to locomotion on land and water, the transmission of power, and other similar purposes.

SERIES OF CHRISTMAS CARDS. Published by Hildesheimer and Faulkner, 41, Jewin-street, London, E.C.

In the collection of cards which Messrs. Hildesheimer have issued for the present season, there is a great variety of designs by a large number of artists, many of whom have not contributed to the series of former years. The collection consists of floral studies, mountain and river scenery, female figures, and humorous scenes. Roses, ferns, holly, and waterside flowers are fully represented, both separately and in groups. Scenes from the opera of "Patience" also find a place. It was "A Dream of Patience," by Miss Alice Havers, which obtained the £200 prize at the Exhibition of Designs for Christmas Cards at the Suffolk-street Gallery. As well as the subjects, the forms of these cards are very varied, there are miniature screens, plaques, picture frames, &c. The artists who have chiefly produced the designs are Messrs. Maurice Page, A. Glendinning, W. J. Hodges, H. H. Couldery, H. M. Burnside, C. J. Noakes, Reginald Jones, H. E. Duffield, E. K. Johnson, Mark Oddy, Henry Bright, Ernest Wilson, W. J. Muckley, and Barclay, and Mrs. Grey, and the Misses Kate Sadler, Alice Havers, and Manley. Besides these cards Messrs. Hildesheimer have produced some children's illustrated books in colours. These are the "Three Maids of Lee," and a companion in the "Three Young Men of Ware;" also "Told in the Twilight," by F. E. Weatherby, illustrated by M. E. Edwards and J. C. Staples. This last contains full page plates of delicate colouring, and elegant borders round the verses.

MR. J. H. GOOD, of 21, Upper Hamilton-terrace, N.W., Member of the Society of Arts, will be glad to present his numbers of the *Journal*, from 1870 to 1882, to the library of any institution not possessing them. Application should be made direct to Mr. Good.

General Notes.

SWISS PATENT LAW.—The *Daily News* reports that at the Swiss Congress recently summoned to discuss the subject of the Patent Law, resolutions were passed recommending the Government to adopt some measure for the protection of inventions. The meeting was animated, and the opposition considerable, especially from the manufacturers of cotton and aniline dyes. The resolution was finally passed by 110 votes to 52. No opposition was offered to the introduction of a "Trade Marks" law.

FORTHCOMING EXHIBITIONS.—According to the continental papers, there will be held next year, at Stockholm, a Scandinavian Industrial Exhibition. Preparations are also spoken of in Nuremberg, in connection with an exhibition of industrial art to be held there in 1885. In that year the new building of the Bavarian Industrial Museum will be completed, and the exhibition referred to will appropriately celebrate its opening. As at present intended, the exhibition will include works in copper, gold, silver, tin, and zinc, as well as the alloys of these metals, art bronzes, goldsmiths' and silversmiths' work, castings of zinc, &c. In the latter branch, special attention will be paid to imitations of bronze works and galvano-plastic processes. The mechanical and historical features of the various subjects will be appropriately illustrated.

COAL IN NEW SOUTH WALES. — The coal measures of the colony embrace an area of about 23,950 square miles. The seams worked vary from 3 feet to 25 feet in thickness, are nearly horizontal, and are in some localities considerably above sea-level. There are at the present time forty-one collieries at work, employing in the aggregate above and below ground 4,125 miners and others. In addition to the foregoing there are two mines at which very valuable seams of petroleum oil, cannel coal, or kerosene shale are being worked. The number of men employed at these mines above and below ground is 231. Since 1865, when the working of these seams commenced, the output has been 241,284 tons, valued at £581,046. There are three principal coal-mining districts; the Hunter River and Newcastle Coal-field, situated to the North of Sydney; the Southern of Illawarra Coal-field; and the Western or Lithgow Coal-field, upon the Great Western Railway-line, about 95 miles west from the metropolis. Coal is also being worked near Berrima, between Illawarra and Lithgow; and some seams are known to occur in the country lying between Lithgow and the Hunter River. Sydney, therefore, occupies an almost central position with regard to the coal-mining districts, and beyond these coal has been discovered in different parts of the colony, viz., near Inverell, Denisontown, Dubbo, Barraba, Clarence, &c.

Journal of the Society of Arts.

No. 1,615. Vol. XXXII.

FRIDAY, NOVEMBER 2, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

ON SECONDARY BATTERIES AND THE ELECTRICAL STORAGE OF ENERGY.

By Professor Oliver Lodge, M.A., D.Sc.

Lecture I.—Monday, May 21st, 1883.

The ordinary methods of storing energy at present in use may be divided roughly into mechanical, chemical, and electrical. As an example of the first kind, we may take the raising of weights, which is accomplished on a large scale hydraulically, and is applied to the working of cranes and dock-gates; another example is the coiling of springs, as in clocks and musical boxes. An example of a chemical store of energy is gunpowder; another is zinc or other smelted metal; and a third example is vegetation, whence arises all the energy of coal and gas engines. The charging of a Leyden jar, and the decomposition of dilute acid, furnish examples of electrical storage, and the explosive gases derived from the last-mentioned operation could doubtless be used to drive some form of gas-engine.

All these methods of storing energy involve some loss, and many of them are accompanied with a great deal of loss. The advantage of being able to store energy frequently outweighs the disadvantage of a considerable amount of loss of energy in the process; and there are three main cases in which this occurs.

One is when regularity and continuity of supply of energy is needed, and when the source of energy to be utilised is irregular and fitful. For instance, it would be convenient to be able to store wind or wave power, and utilise it in an equable and dependable manner.

Another case is when occasional power is needed at times when the source of energy is not acting, or when a very great power is required for a short time, whereas the source of energy at your command has a steady but insufficient power. This would be exemplified in the utilisation of a small engine for lighting purposes.

The third case is when the power at your disposal is so great and so unutilised that the saving of even a fraction of it is a clear gain, no matter what becomes of the rest. This case frequently occurs when natural water-power is utilised. Processes of vegetation also utilise but a meagre proportion of the solar radiation, but the small proportion saved and stored up in the coal fields represents so much clear gain.

The mode of electric storage which has recently excited so much interest involves the use of a secondary battery, which may be defined as an instrument for receiving the energy of an electric current, and for giving it out again in the same form. This is a case of storage without transmutation, such as is also accomplished in the simple operation of winding a clock, where mechanical energy is taken in, to be subsequently given out in the same form. But in the electro-chemical decomposition of acid, the energy of an electric current is stored in such a way as to give sound, and heat, and light, and motion, but not an electric current under ordinary circumstances. There is one arrangement for making the evolved gases directly furnish an electric current, and that is a true secondary battery, viz., Grove's gas battery, or a voltameter.

A primary battery means one in which the plates have been made, or prepared and rendered active, by chemical means; a secondary battery means one in which the activity of the plates depend upon electrical energy having been first expended upon them. Any two conducting bodies, immersed in a conducting liquid able to chemically attack one of them more than the other, constitutes a battery; and the difference in the attackability of the two bodies or "plates" may be caused either by making them originally of different materials, or else by modifying their surfaces in some way, permitting the main bulk of them to remain identical.

Most run-down batteries can be re-excited by forcing a reverse current through them, and they then become true secondary batteries.

The polarisation of voltameter plates was studied by Gautherot, Ritter, and Grove, in

the earlier years of the century; and more recently and exhaustively by Planté, who found that plates of lead acted extremely well, and retained their energy for a long time.

The gas battery consists of two similar platinum plates, one soaked, or coated, or alloyed, with hydrogen, the other with oxygen. But the quantity of oxygen which platinum can store up is very minute; the advantage of using a metal actually oxidisable is manifest. Platinum, and still more palladium, have considerable holding power for hydrogen, but by the use of a salt or an oxide as a recipient of the hydrogen, a far greater amount of reversible action can be stored up than by attempting to store up the hydrogen itself by any power of occlusion.

A Planté cell, from the beginning, furnishes an oxidisable plate on the positive side, but its negative plate has at first no practical occluding power for hydrogen.

Reversing a once charged Planté cell, however, we get metallic lead for the oxidisable plate, and an already oxidised, and therefore reducible, plate to receive the hydrogen; the oxide gradually being reduced to metallic lead, of a porous or spongy consistency. By many reversals of this kind, Planté "formed" his cells, until the lead plates were deeply acted on, and a considerable storage capacity obtained.

The modification of Faure consisted in providing both an oxidisable and a reducible porous material from the very first, by coating the plates with minium or litharge. The plates could then be peroxidised, and reduced respectively to a considerable depth, without any tedious process of "formation." A considerable storage capacity was thus obtained, but difficulties presented themselves connected with the adhesion of the coatings to the plates, and these were not got over until perforated plates were employed to hold the applied substances. Perforated plates, by rendering unnecessary any jacket of cloth or felt to keep the coating on, and by thus permitting a free circulation of the liquid, no doubt are a considerable improvement; and cells, as now made, often work extremely well; at the same time a layer of uniform thickness spread all over the plate, and not locally distributed in a non-homogeneous manner, would seem theoretically to be preferable, if the practical difficulties connected with such a uniformly spread layer had not seemed too great. Plates made in the old manner did not safely bear transport and rough usage, and a film of insulating sulphate of lead was apt sometimes to creep between the metallic lead and the peroxide coating, and to destroy all electrical connection between them over large patches.

The process of manufacture, as now carried on, is here illustrated by a number of specimens of plates in different stages, kindly lent for the purpose by the Electrical Power Company, of Millwall.

The first operation is the casting of the lead grid, the holes in the plate being from $\frac{1}{4}$ in. to $\frac{3}{8}$ in. square. The positive grid is made a little thicker than that which is to be the negative, for reasons which will shortly appear. The thickness of the grids at present most employed are, positive, $\frac{1}{8}$ in. to $\frac{1}{6}$ in.; negative, $\frac{1}{12}$ in. to $\frac{1}{8}$ in., and they are made in two sizes, one $7\frac{1}{4}$ in. by $5\frac{1}{4}$ in., the other 9 in. by 10 in.; the former being used in the small or "half horse-power" boxes, the larger plate being used in all other sizes, it being found more convenient to vary the number of plates in a cell than to have in stock a number of different sized plates. The weights of the formed plates are, small size negative, 15 oz., small size positive, 21 oz.; large size negative, 50 oz., large size positive, 70 oz., about.

The next operation is the filling of the grids with a paste of oxide of lead mixed with dilute sulphuric acid. The negative plates are filled with litharge, PbO, the positive with minium, Pb_3O_4, since there is an evident economy in having to reduce only the lower oxide, and to peroxidise only the higher one.

The plates are then taken to be "formed" by the electric current, for which purpose they are packed alternately in square stoneware jars filled up with dilute sulphuric acid, and a current of about two or three ampères per pair of plates supplied. At the first instant of immersion in acid, a darkening of the minium occurred, owing to a partial formation of peroxide in it by the action of the acid; and this darkening continues, under the influence of the nascent oxygen liberated by the current, until the whole of the composition is converted into peroxide. The litharge is, on the other hand, gradually reduced to metallic lead by the action of the nascent hydrogen produced by the current, the reduced lead having a slightly porous or spongy consistency.

No gas is evolved from the cells for some time; it is all consumed in effecting these chemical changes. A few minute oxygen bubbles do, however, make their appearance on the positive plate, much of it being in the form of ozone. Ultimately, as the surface of

the positive plate gets peroxidised over, a good deal of oxygen escapes, and it is only after a long-continued current that the portions of minium in the interior get acted upon. In time all the minium is attacked, however deeply buried; the reason being that less E.M.F. is needed to send the current to an oxidisable substance than to saturated peroxide. The reduction of the litharge is a somewhat slower process, but the plates being thinner, it is accomplished in approximately the same time, which may be taken as between three days and a week. When the process is approaching completion, torrents of both kinds of gas rise from their respective plates. The plates are then removed from the forming pot, rinsed plentifully with water to remove the excess of acid, and then stacked till wanted. Unless the rinsing operation is carried out, the spongy lead plates are found to heat considerably, by reason of the acid in their pores combining with the lead.

In order to keep the plates from touching each other when subsequently used in battery cells, various devices have been tried. The one now most in favour is to punch out the composition from a tolerable number of the holes of each negative plate, and to insert instead a block of vulcanised india-rubber in each. These plugs project nearly a quarter of an inch on either side the face of the plate, and effectually prevent the adjacent positive from coming into contact with it.

Another matter which has given some trouble to determine is the best method of connecting the plates together. All the positive and all the negative plates in a cell have to be electrically connected in the most complete and permanent manner. Clips and clamps of various kinds have been tried; but, to guard against all possibility of corroded surfaces and imperfect connection, it is now thought wise always to use solder, whether in combination with screw clamps, or otherwise, and to protect the joint from the action of acid spray by a varnish, or by a mass of paraffin. It is curious to notice how persistently the junction of the + plates tend to corrode, showing how the oxidising action creeps up liquid films on the lugs.

When the plates are to be used, they are packed alternately in glass or ebonite boxes, the india-rubber plugs keeping them apart, and wooden supports keeping them off the bottom of the cell. Their lugs are connected together, and the box is filled with dilute sulphuric acid, say, of specific gravity 1·100 or 1·150. A charging current is then supplied, so as to freshen up the plates, and they are then discharged, and charged up again once or twice, to bring them into good condition. It is not a good plan to discharge them too completely, nor to let them remain idle for very long together; neither should they be charged or discharged too rapidly, so as to heat them above a gentle warmth. The more regularly they are worked—as for instance, when they receive a charge every day and discharge every evening—the better they behave. Regularly and carefully worked cells will keep in good order for a very long time; but if they remain idle for weeks together, some of the plates are apt to warp, and otherwise give trouble and require attention. They must not be overcharged very excessively either. When full, they indicate the fact by evolving a good deal of gas, and it is best not to continue the charging power much longer when this stage is fully reached, partly because nearly all the charge then put in is wasted, but principally because a little of the oxygen is absorbed by the lead of the grid, and it therefore gets slowly peroxidised, so that, after a sufficient lapse of time, it may get actually eaten through, and the plate become friable. When a plate has got into this state, the only plan seems to be to melt it down with a flux, and recover the lead. But the complete peroxidation of a plate by overcharging is a work of time, by far the greater quantity of gas being harmlessly, though wastefully, set free; and it is not necessary to be alarmed at a slight evolution of gas which usually goes on from the positive plate when being charged, more especially as the cell is getting full. Alarm at the appearance of bubbles may lead to the cell never being properly filled up, in which case the battery will fail to work satisfactorily.

The number of plates which are packed into each box depends entirely upon the size of the box, and it is in this way that the different sized cells are constructed, not by varying the size of the plates; except that the smallest cells are made with half-sized plates.

Taking the full-sized plates, we may reckon that each pair is able easily to receive and give out electricity at the rate of 4 ampères per pair. This of course reckons both faces of each plate as active. This process may be continued for, say, 8 hours on the average, consequently the storage capacity of a cell is 32 ampère hours per pair of plates. The E.M.F. of discharge is as nearly as possible 2 volts,

consequently the power of a cell is 8 watts per pair of plates; and the total available energy per pair of plates, when full, is 8 watts for 8 hours, or 170,000 foot-pounds; which may be also, though clumsily, expressed as 1-12th of a horse-power-hour per pair of plates. Consequently, a box which is to give 1 horse-power-hour should contain 12 pair of plates; a 2 horse-power box 24 pair, and so on. But each box will not really give a horse-power for an hour, it will rather give an eighth of an horse-power for 8 hours. If a horse-power is wanted, all you need do is to take 8 cells, and then they will give you a horse-power and will last 8 hours; 16 cells will give 2 horse-power for the same time, and so on. By drawing off the power more slowly, the discharge will last longer, and it is more economical thus to work, except as regards first cost of batteries. This latter item it is which usually causes them to be called upon to exert power up to their maximum reasonable capacity. It is true that a cell will give a much higher power for a short time if called upon—thus a single cell might possibly be made to give a horse-power, but then it would not last out its proportionate time. I have found some cells, which I discharged at a very moderate rate, continue discharging an extraordinary time, and give out sometimes even more than was put in, which, of course, means that the effect of previous charges was being drawn upon.

When a cell which is being rapidly discharged has apparently run completely down, a few minutes rest will suffice to recover it a little; and after an hour or two's rest a cell will commonly have recovered sufficiently to enable it to discharge with something of its old vigour for a period comparable with that of the rest. This recuperative power of the cells is in some respects advantageous, but, on the whole, it would be better if they gave out the whole of their energy continuously without needing intervals for refreshment. The more slowly a cell is discharged, the less noticeable is this temporary falling off and subsequent recovery.

When a cell has run down, it is interesting to examine which of its three constituents is the one that has failed; the positive plate, the negative plate, or the acid. Sometimes, especially in cells too crowded with plates, there is not enough acid present; the free acid is absorbed by the lead, and only water is left. The specific gravity of the acid may however be easily watched by floating a little hydrometer in the cell. More frequently the negative plate is the first to fall off; as may be shown by removing it and inserting a fresh one, when the cell will go on again. The cause of this, and of several other peculiarities observed in batteries, may be readily made out by experiments on a small scale, on two little plain lead strips, held in a convenient clamp, and immersed in dilute acid.

To a pair of such strips of sheet lead supply a current, from a couple of Groves, say, for half an hour or so. The positive plate is seen to become coated with a puce layer which gradually darkens to black. The other plate seems unchanged. Gas is evolved from both plates. On now connecting them with an electric bell, it will ring for a minute or more. Now re-charge, but this time, instead of discharging the cell, remove the negative plate, and insert instead a bit of clean lead, the same in appearance as the one against which hydrogen has been so long liberated, and then discharge the cell; it will only ring the bell for about two seconds. Depress the plain lead plate further into the acid, so as to expose a fresh surface, and the bell will give a few more strokes. Remove this plate altogether, and re-insert the hydrogenised plate which had been used for charging the cell, and the bell rings vigorously for as long a time as it did in the first experiment, showing that the peroxide plate is perfectly vigorous, and showing also that the nascent hydrogen has modified the lead in some way or other.

The natural supposition is that the lead has occluded hydrogen, but Dr. Frankland has shown that, if such hydrogenised lead be melted down, it gives off no hydrogen worth mentioning. It is not easy to see wherein the change consists. Under the microscope, the hydrogenised plate looks a little darker than the plain plate, but no real porosity is noticeable. The fact, however, is certain, that it behaves in a very different manner to plain lead, and that it retains this singular power long after it has been removed from the liquid and rinsed.

To avoid misunderstanding, it might have been well to state earlier that I use the term "positive plate" to signify that at which the charging current enters, and from which the discharge current leaves. It is that one whose terminal is coloured red in the cells of commerce. It is that which must be joined to the + pole of a magneto-machine, whether the latter is to act as a generator or a motor. I make no distinction between positive plate and positive pole, because all such distinctions end in confusion.

The plain lead plate which refused to give a current when opposed to peroxide, did not fail because of its high position in the electro-chemical series, as may be proved by opposing it to the hydrogenised plate, when it is equally inert; it fails simply and solely on account of a film of some non-conducting substance which spreads over its surface the instant it is used as one electrode of a battery, the substance appearing to be sulphate of lead. The internal resistance of the cell thus becomes enormous, and the current ceases. On standing idle for a time, the film has a chance of clearing off—though from a plain lead plate I do not notice much tendency to clear—or it may be wiped off with a cloth at once; but a fresh film speedily forms. If amalgamated lead be used, the white scum can be seen, and it sometimes drops off in a filmy sheet. One remarkable way of instantly clearing off the scum is to touch the lead under the liquid with a scrap of amalgamated zinc. The effect is magical: the scum vanishes, and the bell again rings for several seconds after the zinc has been removed. So long as the zinc is present the current will continue, until indeed the positive plate becomes exhausted.

To examine whether the positive plate also exhibits the temporary falling-off, and to eliminate the concurrent action of the negative, the best plan is to use a piece of amalgamated zinc for the latter; for since sulphate of zinc is soluble, it remains perfectly clear, and all variation is traceable at once to the behaviour of the positive. Under these circumstances, the cell, if rapidly discharged, does show a slight recuperative power, recovering somewhat on standing. So far as I can make out, this appears to be mainly due to a temporary exhaustion of the acid close to the surface and in the pores of the peroxide, so that the power falls until, by rapid diffusion, the absolved acid has been replenished. The insulating scum of sulphate on the negative plate is, however, by far the most powerful cause of the ordinary running down of a cell.

When we come to try the hydrogenised plate employed in charging the cell instead of the plain plate, we find that it also ceases to act before the positive is exhausted, though it is able to go on for a considerable time; it ultimately acquires a scum. On standing, the scum clears off partially, and the cell recovers. A piece of zinc made to touch the plate under the liquid, clears it, and in a short time restores it to its original power, having precisely the same effect as a re-application of the charging current. The fact is not surprising, since the zinc naturally causes nascent hydrogen to be liberated on the plate, just the same as a current would; but the quick and prompt action of the merest scrap of zinc is somewhat striking, and some practical application of the fact would seem to be possible.

Instead of a plain lead plate, lead sponge may be employed for the negative plate, such as is made by Watt, of Liverpool, by blowing high pressure steam through a jet of molten lead, or such as Mr. Desmond FitzGerald has brought me here, made in some other way. The enormous surface of this spongy lead enables it to go on acting for a much longer time than plain lead, without being stopped appreciably by a scum. This effect is due to the extent of surface, and it appears to be owing to a sort of potential hydrogenation caused by the ability of acid to attack spongy lead, or any metal in a fine state of division, more easily than when massive; and the sulphate of lead formed, though it certainly clogs up the pores, is not readily able to form a continuous protecting film.

A thin coat of peroxide formed on a lead plate rapidly becomes lighter in colour when the current is stopped, being evidently reduced to a lower oxide by local action with the lead underneath. When the coat is very thin, the changes go on so rapidly that, by quickly pressing the charging battery key down and up, flashes of peroxide appear and disappear on the surface. It is by this local action effect, no doubt, that peroxidation eats deeper and deeper into metallic lead, for otherwise, as soon as a complete layer of peroxide was once formed, all subsequent gas would be given off from its surface (it being a conductor), and the lead beneath would be protected.

The local action proclivity between lead and peroxide has two unpleasant consequences, however; one is that the peroxide gradually disappears on long standing, and the cell thus loses its charge; the other is that the metallic lead of the plate gets gradually eaten into, and corroded away. These two results are modified in practice by the fact that, whereas local action destroys the peroxidation of thin films in an instant, in the deeper layers of thick films it goes on very slowly, partly because fresh acid cannot so easily penetrate, but principally because the sulphate and lower oxides formed, being non-conductors, exert a clogging and protective action.

Instead of using a lead negative plate, a copper-plate may be used, and will give a

strong and lasting current. It lasts, of course, because copper sulphate is soluble, and no insulating scum is formed; but that this Sutton cell has a fairly high E.M.F., is a striking proof of the value of peroxide of lead as the electro-negative element of a battery.

Even platinum gives a current when opposed to peroxide of lead, though of course it is a feeble one. But if zinc is used, we have the strongest practicable battery I know, each cell having an E.M.F. of $2\frac{1}{2}$ volts.

Miscellaneous.

LONDON INTERNATIONAL EXHIBITIONS.

In closing the Fisheries Exhibition on Wednesday last, H.R.H. the Prince of Wales anuounced that it is proposed to hold in the buildings at South Kensington, during the next three years, the following International Exhibitions:—

1884. A Sanitary and Educational Exhibition, comprising Health as applied to Food and Drink, the Dwelling, and Dress; also General and Technical Education.

1885. An Exhibition of Industrial Inventions, especially Labour-saving machinery.

1886. An Indian and Colonial Exhibition.

In making this announcement, his Royal Highness said—

"It is a source of great gratification to me to be able to continue the work commenced by my father in 1851; and, by giving scope for the peaceful emulation of the leaders of industry of all nationalities in public Exhibitions, to divert the minds of men from those international rivalries by which all suffer, to those by which all gain. The evidence of the public interest in these Exhibitions, afforded by the vast concourse of visitors from all parts of the realm to that which is now closed, has led me to hope that the buildings which have been erected at so much cost, and which have so admirably served their purpose, shall continue, for the next three years, to be employed for Exhibitions of a similar comprehensive character. In considering what shall be the subject matter of these Exhibitions, three topics of paramount interest to our community have presented themselves to my mind. These are health, both bodily and mental; industrial inventions; and the rapidly growing resources of our colonies and of our Indian Empire. I have expressed a desire that the Exhibition of 1884 shall embrace the conditions of health, in so far as, like food, clothes, and dwellings, they fall under the head of hygiene; or, like appliances for general and technical teaching, gymnasia, and schools, under that of education. The question of the Patent Laws has for many years engaged the attention of all those interested in the progress of invention and the just reward of the inventor. I am advised that the Patent Act of last Session will afford a satisfactory solution of the difficulties which beset this subject, and will be especially useful to the poor inventor, by enabling him to obtain protection for his invention at a considerably reduced rate, and in a manner which will be more advantageous to him. Under these circumstances, it has appeared to me that much good may result from an Exhibition in the year 1885, showing the progress of invention, especially in labour-saving machinery, since 1862—that is to say, since the last great International Exhibition held in this country. At the close of the Paris Exhibition of 1878, I had the satisfaction of receiving from the Colonial Commissioners an address, in which great stress was laid on the desirability of establishing a permanent Colonial Museum in London, as a powerful means of diffusing throughout the mother country a better knowledge of the nature and importance of the several dependencies of the empire, of facilitating commercial relations, marking progress, and aiding the researches of men of science, and also of affording valuable information to intending emigrants. At that time I was able to do little more than to assure the Commissioners of my readiness to promote such a scheme, and to recommend the respective Governments to give it their full consideration. I trust that the British Colonial Exhibition which I propose to hold in 1886, may result in the foundation of such a museum—the institution of which would secure for the people of this country a permanent record of the resources and development of her Majesty's Colonies; and I hope that an important section of the proposed exhibition of that year may result from the co-operation of our fellow subjects, the people of India, in a suitable representation of the industrial arts of that country."

It will be noted that all the selected subjects are nearly associated with the work of the Society of Arts. The Society's Sanitary Conferences (1876 to 1880), and the Conference on Water Supply, held at the instance of H.R.H. the Prince of Wales, in 1878, were amongst the principal means of directing public attention to the question of healthful dwellings. The Food Committee, a very few years back, published several valuable reports; and since its foundation, the cheapening of the food supplies of the people has been one of the most important departments of the Society's work. General education it has long dealt with by its examinations; technical education it fostered and encouraged, till the movement it had initiated resulted in the establishment of the City Technical Institute,

and the first Educational Exhibition ever held was held by the Society in 1854. The history of invention in England, for the past 130 years, is the history of the Society of Arts. Finally, "His Majesty's Colonies and Plantations abroad" owed not a little, in their early days, to the Society for the introduction to English industry of their various productions; while of recent years, the Society's Indian and Colonial Sections have kept up the associations of one of its chief branches of work at, and soon after, the time of its foundation.

The scheme of these Exhibitions is, therefore, one which appeals in a peculiar manner to the members of the Society of Arts, since they cannot fail to promote the special objects for which the Society was founded, nearly a century and a-half ago.

CHINA GRASS.

The following article appeared in a recent number of the *Times* :—

The subject of the cultivation and commercial utilisation of the China grass plant, or rhea, has for many years occupied attention, the question being one of national importance, particularly as affecting India. Rhea, which is also known under the name of ramie, is a textile plant which was indigenous to China and India. It is perennial, easy of cultivation, and produces a remarkably strong fibre. The problem of its cultivation has long being solved, for within certain limits rhea can be grown in any climate. India and the British colonies offer unusual facilities, and present vast and appropriate fields for that enterprise, while it can be, and is, grown in most European countries. All this has long been demonstrated; not so, however, the commercial utilisation of the fibre, which up to the present time would appear to be a problem only partially solved, although many earnest workers have been engaged in the attempted solution. There have been difficulties in the way of decorticating the stems of this plant, and the Indian Government, in 1869, offered a reward of £5,000 for the best machine for separating the fibre from the stems and bark of rhea in its green or freshly cut state. The Indian Government was led to this step by the strong conviction, based upon ample evidence, that the only obstacle to the development of an extensive trade in this product was the want of suitable means for decorticating the plant. This was the third time within the present century that rhea had become the subject of official action on the part of the Government, the first effort for utilising the plant dating from 1803, when Dr. Roxburg started the question, and the second from 1840, when attention was again directed to it by Colonel Jenkins. The offer of £5,000, in 1869, led to only one machine being submitted for trial, although several competitors had entered their names. This machine was that of Mr. Greig, of Edinburgh, but after careful trial by General (then Lieutenant-Colonel) Hyde it was found that it did not fulfil the conditions laid down by the Government, and therefore the full prize of £5,000 was not awarded. In consideration, however, of the inventor having made a *bonâ-fide* and meritorious attempt to solve the question, he was awarded a donation of £1,500. Other unsuccessful attempts were subsequently made, and eventually the offer of £5,000 was withdrawn by the Government.

But although the prize was withdrawn, invention did not cease, and the Government, in 1881, re-offered the prize of £5,000. Another competition took place, at which several machines were tried, but the trials, as before, proved barren of any practical results, and up to the present time no machine has been found capable of dealing successfully with the plant in the green state. The question of the preparation of the fibre, however, continued to be pursued in many directions. Nor is this to be wondered at when it is remembered that the strength of some rhea fibre from Assam experimented with in 1832 by Dr. Forbes Royle, as compared with St. Petersburg hemp, was in the ratio of 280 to 160, while the wild rhea from Assam was as high as 343. But, above and beyond this, rhea has the widest range of possible applications of any fibre, as shown by an exhaustive report on the preparation and use of rhea fibre by Dr. Forbes Watson, published in 1875, at which date Dr. Watson was the reporter on the products of India to the Secretary of State, at the India-office. Last year, however, witnessed the solution of the question of decortication in the green state in a satisfactory manner by M. A. Favier's process, as reported by us at the time. This process consists in subjecting the plant to the action of steam for a period varying from 10 to 25 minutes, according to the length of time the plant had been cut. After steaming, the fibre and its adjuncts were easily stripped from the wood. The importance and value of this invention will be realised, when it is remembered that the plant is cultivated at long distances from the localities where the fibre is prepared for the market. The consequence is, that for every hundredweight of fibre, about a ton of woody material has to be transported. Nor is this the only evil, for the gummy matter in which the fibre is embedded becomes dried up during transport, and the separation of the fibre is thus rendered difficult, and even impossible, inasmuch as some of the fibre is left adhering to the wood. M. Favier's process greatly simplifies the commercial production of the fibre up to a certain point, for, at a very small cost, it gives the manufacturer the whole of the fibre in the plant treated. But it still stops short of what is required, in that it delivers the fibre in ribands, with its cementitious matter and outer skin attached. To remove this, various methods have been tried, but, as far as we are aware, without general success—that is to say, the fibre cannot always be obtained of

such a uniformly good quality as to constitute a commercially reliable article. Such was the position of the question when, about a year ago, the whole case was submitted to the distinguished French chemist, Professor Frémy, member of the Institute of France, who is well-known for his researches into the nature of fibrous plants, and the question of their preparation for the market. Professor Frémy thoroughly investigated the matter from a chemical point of view, and at length brought it to a successful and, apparently, a practical issue.

One great bar to previous success, would appear to have been the absence of exact knowledge as to the nature of the constituents of that portion of the plant which contains the fibre, or, in other words, the casing or bark surrounding the woody stem of the rhea. As determined by Professor Frémy, this consists of the cutose, or outer skin, within which is the vasculose containing the fibre and other conjoined matter, known as cellulose, between which and the woody stem is the pectose, or gum, which causes the skin or bark, as a whole, fibre included, to adhere to the wood. The Professor, therefore, proceeded to carefully investigate the nature of these various substances, and in the result he found that the vasculose and pectose were soluble in an alkali under certain conditions, and that the cellulose was insoluble. He therefore dissolves out the cutose, vasculose, and pectose by a very simple process, obtaining the fibre clean, and free from all extraneous adherent matter, ready for the spinner. In order, however, to insure as a result a perfectly uniform and marketable article, the Professor uses various chemicals at the several stages of the process. These, however, are not administered haphazard, or by rule of thumb, as has been the case in some processes bearing in the same direction, and which have consequently failed, in the sense that they have not yet taken their places as commercial successes. The Professor, therefore, carefully examines the article which he has to treat, and, according to its nature and the character of its components, he determines the proportions of the various chemicals which he introduces at the several stages. All chance of failure thus appears to be eliminated, and the production of a fibre of uniform and reliable quality, removed from the region of doubt into that of certainty. The two processes of M. Favier and M. Frémy have, therefore, been combined, and machinery has been put up in France on a scale sufficiently large to fairly approximate to practical working, and to demonstrate the practicability of the combined inventions. The experimental works are situated in the Route d'Orleans, Grand Montrouge, just outside Paris, and a few days ago a series of demonstrations were given there by Messrs. G. W. H. Brogden and Co., of Gresham-house, London. The trials were carried out by M. Albert Alroy, under the supervision of M. Urbain, who is Professor Frémy's chief assistant and co-patentee, and were attended by Dr. Forbes Watson, Mr. M. Collyer, Mr. C. J. Taylor, late member of the General Assembly, New Zealand, M. Barbe, M. Favier, Mr. G. Brogden, Mr. Caspar, and a number of other gentlemen representing those interested in the question at issue.

The process, as carried out, consists in first treating the rhea according to M. Favier's invention. The apparatus employed for this purpose is very simple and inexpensive, consisting merely of a stout deal trough or box, about 8 ft. long, 2 ft. wide, and 1 ft. 8 in. deep. The box has a hinged lid and a false open bottom, under which steam is admitted by a perforated pipe, there being an outlet for the concondensed water at one end of the box. Into this box the bundles of rhea were placed, the lid closed, steam turned on, and in about twenty minutes it was invariably found that the bark had been sufficiently softened to allow of its being readily and rapidly stripped off by hand, together with the whole of the fibre, in what may be called ribands. Thus the process of decortication is effectively accomplished in a few minutes, instead of requiring, as it sometimes does in the retting process, days, and even weeks, and being at the best attended with uncertainty as to results, as is also the case when decortication is effected by machinery. Moreover, the retting process, which is simply steeping the cut plants in water, is a delicate operation, requiring constant watching, to say nothing of its serious inconvenience from a sanitary point of view, on account of the pestilential emanations from the retteries. Decortication by steam having been effected, the work of M. Favier ceases, and the process is carried forward by M. Frémy. The ribands having been produced, the fibre in them has to be freed from the mucilaginous secretions. To this end, after examination in the laboratory, they are laid on metal trays, which are placed one above the other in a vertical perforated metal cylinder. When charged, this cylinder is placed within a strong iron cylinder, containing a known quantity of water, to which an alkali is added in certain proportions. Within the cylinder is a steam coil for heating the water, and, steam having been turned on, the temperature is raised to a certain point, when the cylinder is closed and made steam-tight. The process of boiling is continued under pressure until the temperature—and consequently the steam pressure—within the cylinder has attained a high degree. On the completion of this part of the process, which occupies about four hours, and upon which the success of the whole mainly depends, the cementitious matter surrounding the fibre is found to have been transformed into a substance easily dissolved. The fibrous mass is then removed to a centrifugal machine, in which it is quickly deprived of its surplus alkaline moisture, and it is then placed in a weak solution of hydrochloric acid for a short time. It is then transferred to a bath of pure cold water, in which it remains for about an hour, and it is subsequently placed for a short time in a weak acid bath, after which it is again washed in cold water, and dried for the market. Such are the processes by which China

grass may become a source of profit alike to the cultivator and the spinner. A factory situate at Louviers has been acquired, where there is machinery already erected for preparing the fibre according to the processes we have described, at the rate of one ton per day. There is also machinery for spinning the fibre into yarns. These works were also visited by those gentlemen who were at the experimental works at Montrouge, and who also visited the Government laboratory in Paris, of which Professor Frémy is chief and M. Urbain *sous-chef*, and where those gentlemen explained the details of their process and made their visitors familiar with the progressive steps of their investigations.

With regard to the rhea treated at Montrouge, we may observe that it was grown at La Reolle, near Bordeaux. Some special experiments were also carried out by Dr. Forbes Watson with some rhea grown by the Duke of Wellington at Stratfield-saye, his Grace having taken an active interest in the question for some years past. In all cases the rhea was used green and comparatively freshly cut. One of the objects of Dr. Watson's experiments was, by treating rhea cut at certain stages of growth, to ascertain at which stage the plant yields the best fibre, and consequently how many crops can be raised in the year with the best advantage. This question has often presented itself as one of the points to be determined, and advantage has been taken of the present opportunity with a view to the solution of the question. Mr. C. J. Taylor also took with him a sample of New Zealand flax, which was successfully treated by the process. On the whole, the conclusion is that the results of the combined processes, so far as they have gone, are eminently satisfactory, and justify the expectation that a large enterprise in the cultivation and utilisation of China grass is on the eve of being opened up, not only in India and our colonies, but possibly also much nearer home.

THE PRODUCTION, POPULATION, AND TRADE OF YUCATAN.

Consul Aymé, of Merida, says that the State of Yucatan is, in its northern portion, a level plain of recent geological formation; its soil is exceedingly poor, being but a few inches in depth, and very stony. There are no rivers or streams on the surface, but large subterranean rivers are known to exist. Caves, usually of small extent, are found everywhere, always containing water; these are usually termed "cenotes." The poverty of the soil and complete absence of water makes this part of Yucatan very barren. There are no forests, and the uncultivated ground is covered with a dense and tangled undergrowth of thorny plants absolutely impassable. It is, however, on this wretched soil that the *henequen* plant thrives and flourishes. West of Campeche there is a low range of mountains extending to the north-east a distance of about a hundred miles, when it makes an acute angle, and then runs about a hundred miles to the south-west. The average height of this range is about 300 feet, and in its immediate vicinity to the north are found large tracts of fertile rich soil capable of growing sugar and coffee. To the south of the range extends a vast territory of the very richest soil, covered with huge forests of mahogany and valuable woods in enormous quantities; among them may be mentioned the *chechen*, the *balsam*, and ironwood. The animals of Yucatan comprise the tapir, the puma, four or five varieties of jaguar, deer, &c. Ornithologically the state is very rich, and it is here that the magnificent wild turkey, or *Meleager ocellatus*, is found in large numbers and the greatest perfection. The fisheries in the gulf are very insignificant, but in quality the fish are unsurpassed. Small but delicious oysters are found at Celestun, on the west coast. As regards the population, the Mayas, who are the native or aboriginal race, form by far the largest portion of the population. They are a hardy intelligent race, of medium or low stature, long arms, chest full and muscular, hair very coarse, straight, and bushy, teeth sound and square in shape. The clothing of the men consists of a pair of wide trousers and a long shirt, sandals and a hat complete their costume. The women wear a species of petticoat, and a peculiar garment called an *ipil*, this is a species of toga cut square in the back, neck, and front, sleeveless, and falling nearly to the ankles. Both of these garments are usually beautifully embroidered, and trimmed with lace. The women have generally long abundant hair, which is worn in a knot at the back of the head, very similar to the coiffure of the Japanese. They are very fond of jewellery, and on all occasions wear a profusion of gold chains and rings. The Mayas are a very cleanly race, bathing usually twice a day, and their garments are of a snowy whiteness. Their food consists chiefly of *tortillas*, or cakes made of crushed corn. The corn is first boiled and then soaked in lye to soften the husks, then washed many times in water: it is afterwards ground with water to a thick paste on stones called *metates*, which are very similar to those used in ancient Egypt. From this paste are formed their circular cakes about six inches in diameter and one-eighth of an inch thick; these are heated through on an iron slab. With the *tortillas* they eat *chile*, or red pepper. Consul Aymé says that the Mayas are quick to learn, and with the abolishment of the peonage system, and a more liberal education and training, would be susceptible of enormous improvement. As it is, they have produced statesmen, physicians, and lawyers, and can be found in every branch of industry. The offspring of the white and Maya races, no matter what may be the degree of admixture of blood, are known as *Mestizos*. In Yucatan there are two seasons, the wet and the dry; the extremes of the wet season may be stated as May 15th and October 31st. During November, December, and January strong north winds blow,

while in February, March, and April hot, dry weather prevails. The greatest heat indoors almost exceeds 90° Fah.: the lowest temperature for the past two years was 60° Fah. Yucatan itself is divided into sixteen districts, Merida, Izamal, Valladolid, Tizimin, Motul, Tixkokob, Temax, Acanceh, Tekax, Peto, Sotuta, Tical, Espita, Maxcanu, Progreso, and Hunucmo. Its population is estimated at 300,000; the capital city is Merida, which is situated about twenty-six miles inland, and covers an area of about four square miles, including its suburbs. It is well constructed, and the houses are generally one story high and built of stone. The trade of Yucatan has of late years greatly increased; for instance, while in 1878 only about 55,000 bales of *henequen* fibre, the chief article of export, were shipped to all parts, in 1880 the United States alone took 85,444 bales, and 11,917 bales were exported to other places, making a total of 97,351 bales; and in 1881, 153,433 bales were shipped. The total value of the *henequen* fibre exported in 1881 was estimated to exceed £580,000.

ITALIAN RAILWAYS.

The Director-General of Italian Railroads has recently published some statistics, from which it appears that, up to January 1st, 1881, there were only 5,412 miles of completed railroad in Italy. Of these, nearly half were in North Italy, in a territory containing about 8,000,000 inhabitants, while the remainder were scattered over Central and South Italy, over a much larger territory, containing 20,000,000 inhabitants. Consul Duncan, of Naples, says that, after a long discussion, and many changes and additions to satisfy the different local interests, a Bill passed Parliament in 1880, providing for the construction of an additional 3,800 miles of roads in different parts of the kingdom. A large proportion of these were in Central and Southern Italy and Sicily, and it is expected that when they are all finished, the Italian network of railroads will be complete. In this network are not included either the projected roads on the island of Sardinia, or a more direct line between Naples and Rome. This latter it is intended to build along the coast *viâ* Gaeta and Terracina, thus shortening the distance nearly one third, and the time nearly one half between these two principal cities. When all the contemplated roads are complete, there will still be less than 10,000 miles of railroads in Italy for a population of 29,000,000, and an area of 114,377 miles; a smaller proportion than any other country of Central or Western Europe, except Spain and Portugal. Compared with other countries, the cost of construction in Italy is exceedingly heavy; the average being about £23,000 per mile, and the estimated cost of some of the projected lines amounts to nearly £32,000 per mile; and the longest line of all, that between Eboli and Reggio, opposite Messina, about 323 miles, will cost to construct, £8,000,000, or over £24,000 per mile. This excessive cost is owing, in a great measure, to the difficult mountainous character of a large portion of the country, and partly by the greater solidity of the roads built, and in part because they are built at public expense and not by private enterprise. The capital for building railway lines in Italy is obtained by a Government guarantee of bonds at five to six per cent., so that as the net average profit of the lines amounts to only about two per cent., the remaining three to four per cent. has to be paid out of the public Treasury. The cost of the Italian lines, completed on the 1st January, 1881, amounted to about £105,000,000. The total gross income for 1880 was about £7,000,000, while the working expenses amounted to about £5,000,000, or nearly five per cent. on cost of construction, leaving only £2,000,000, or about two per cent., as the net income. During the year 1880 the Italian railways carried 32,491,827 passengers, of which 1,154,958 travelled first, 5,594,445 second, and 14,941,808 third-class, while the remaining 10,800,606 were soldiers for account of Government. During the same year trains ran off the line 490 times. There were 347 collisions, 179 persons killed by accident, 688 wounded, and 54 suicides. The most important of all the lines is the one just completed between Novara and the north of Lake Maggiore, by which the port of Genoa is brought into more direct communication with the Saint Gothard road and Switzerland and Germany.

THE DWARF PALM AS A PAPER MATERIAL.

By James Collins.

In a recent number of the *Journal* (August 17th, 1883), there is a short note on the above plant, and the following is a slight account of it.

The Dwarf Palm, *Chæmerops humilis*, of Linnæus, has a great interest in geographical botany, as it marks the northern limit in Europe of the natural orders of palms, being found growing wild as far north as Nice, in 43° 44′ north latitude. In the countries bordering on the Mediterranean Sea, it is very plentiful. In South Grenada it grows up to an elevation of 2,000 feet above the level of the sea, covering large tracts and preventing cultivation; also in Southern Europe generally, Western Asia, and Northern Africa, covering waste and uncultivated ground like our furze (*Ulex Europæus*, Linn), does in this country. In Algiers it is a perfect weed, looked upon even as a scourge, its deep and tough roots giving great trouble to agriculturists; but then "a weed is but an unutilised plant, or a plant in the wrong place."

This palm is naturally of a dwarf habit, of three to four feet high, with long creeping roots, from which spring numerous suckers, forming dense tufts.

If these suckers be removed, the plant attains a height of from 20 to 30 feet. The leaves are fan-shaped, rigid, and furnished with prickles.

The palm is not without its uses. The Arabs use the fibres found at the base of the leaves, mixed with camel's hair, in the fabrication of their tent covers, which are lasting and impervious to rain. The leaves are also used largely in Southern Europe for the making of hats, brooms, baskets, cordage, sails, and also for thatching purposes. In France, as far back as 1854, the dressed fibres were used as a substitute for horsehair, being firm and elastic, and also in the manufacture of carpets, sailcloth, thread, and paper, and known as African or vegetable hair. When freed from resin and properly dressed, although not so long in staple, this fibre has been spoken of as much resembling flax.

Of other species of *Chæmerops*, there are about a dozen cultivated in European gardens. *C. Fortuni*, a native of northern China, grows to a height of from twelve to twenty feet, and its leaves are used in the making hats, and in the manufacture of a kind of coat well suited for wet weather. *C. Richiana*, very common in Afghanistan, furnishes material for hats, fans, brushes, sieves, sandals, pouches, ropes, &c. Its seeds are used as bullets, or for rosaries, and its young leaves, or "cabbage," form an article of food.

The dwarf palm, therefore, seems to fulfil all the conditions necessary for becoming a staple article of commerce. It is plentiful, easily obtained, easily cultivated, if necessary, and if sent over in a semi-prepared or half-stuff condition, the question of freight would not interfere with its utilisation by paper manufacturers.

FIBROUS PLANTS OF MEXICO.

Consul Strother says that there is probably no country in the world which surpasses Mexico in the abundance and variety of its fibrous plants proper and adaptable to the manufacture of paper, yet the cost of this article is most exorbitant. There are twelve paper factories now in the Republic distributed among six different States, and producing an aggregate of about 25,000,000 pounds daily. This product is chiefly of the commoner qualities of wrapping paper, newspaper sheets, with white and coloured sheets for placards and posters. The proportion of the finer qualities of book and writing paper is very small. The materials used are rags, refuse cotton, waste paper, palm fibre, and *ixtle* or magney fibre in small quantities. About thirty per cent. of the paper consumed in the country is of domestic manufacture, the remainder being imported from France, Germany, Italy, Spain, and the United States. Among the many fibrous and textile plants of Mexico suitable for the manufacture of paper, the following may be mentioned. The various species of the magney plant (the sap of which furnishes the national beverage, *pulque*), which grows to an immense size, and whose leaves contain a quantity of tough fibre which may be readily bleached and converted into paper; the varieties of plantain, grown in the warm districts, chiefly for the shade they afford the young coffee plantations, and whose stocks and voluminous leaves furnish a very fine and white fibre in great abundance; *tule*, a tough rush, commonly used by the Indians for weaving mats, floor covers, baskets, and chair bottoms, which is found in unlimited quantities in the fresh water lagoons in the valley of Mexico and elsewhere, and which is very rich in paper-making material; the sugar cane, cornstalks, wheat, rye, and barley straw are also used. Various plants of the *Malvaceæ* species are also largely used, especially the *alacle* found in the State of Morelos; the long white and abundant filament of this plant attracted considerable attention at the Philadelphia Exhibition of 1876; the *Moorhead hibiscus*, abundant on the Gulf Coast, and the *huimeve*, very common in the State of Michoacau; the *bonnetia mamillaria*, and the *Cacteas*, which cover the mountains of Cardonal and Mezquital; the *pochote*, whose seed is enclosed in fine silken filaments resembling cotton; the *cuanlahuac*, of the family of the *Tiliaceæ*, growing in the streets of Morelos and Pueblo, and whose cortical fibres are remarkable for their beauty; indigenous *Urticeæ* of divers species, such as the common nettle of the valley of Mexico, the *Urtica dioica*, besides several species of *Bromeliaceæ*, notably the *Bromelia sylvestris* of Tehuantepec; the *pastles* or *henos*, the *zotes* of the Silaceas, which are extremely abundant in the State of San Luis Potosi, and elsewhere on the elevated plains of the interior States; finally the different species of palms of the Tierra Calientes, especially the "hat palm," which has an extremely tough and fine fibre. In conclusion, Consul Strother says that Mexico, with its wonderful varieties of soil and climate, appears to be the favoured home of fibrous plants, many of which grow spontaneously like wild weeds, covering large extents of country ready for the gathering, while those requiring cultivation, with the advantage of cheap lands, cheap labour, and abundant fertility, may be produced at a very insignificant expense. The general revival of internal and external commerce, the progress of free schools and popular education, the proposed reforms in the postal service, increasing mail facilities, and the lowering of postal charges, all indicate an immense increase in the demand for paper in the immediate future.

THE PRODUCTION OF SMYRNA RAISINS.

Consul Dennis, in his report on the trade and industries of Smyrna, says that dried fruits are the most important of the many exports of Smyrna, employing a vast amount of labour, and giving an adequate return for the outlay of capital. Chief among them are raisins, of which there are four descriptions grown in the district of Smyrna—black,

red, sultanas, and currants. The black, which are exported chiefly to France, are used exclusively for wine-making, and for the distilling of spirit. The red and sultanas are for the table, and fetch a much higher price than the black. The exportation of this fruit has increased considerably during the last few years. The ordinary crop some years since did not exceed 25,000 tons, but the cultivation having been extended to meet the demand, the export, in 1877 and 1878, advanced to 28,500 tons each year, and for the three following years it averaged 48,600 tons, and in value, nearly 1,000,000 sterling. The production of black raisins especially has been largely developed since 1877. In that year France consumed little more than 7,000 tons of this description of fruit; in 1879 her consumption rose to nearly 20,000 tons, and it advanced in 1880 and 1881 to an average of 25,000 tons. As the demand from France, in consequence of ravages of the *Phylloxera* in her own vineyards and a succession of bad vintages, still continues, the cultivation of the vine in the district of Smyrna is extending even in a ratio disproportionate probably to the future demand. Smyrna raisins are of four qualities, the best are grown on the peninsula of Carabournon at the entrance to the Gulf of Smyrna; the second quality at Vourlah within the Gulf, and at Phokes; the third at Chesmé on the coast opposite to Scio; the fourth called Yerli, in the neighbourhood of Smyrna and inland. Between the value of the first and last qualities there is a difference of from 50 to 60 per cent. Currants are also grown at Phokes. The total amount of raisins exported in 1881 was 891,792 quintals, the quintal being equivalent to 124 lbs. avoirdupois, valued at £999,156. The black raisins are consumed almost entirely by France; of the red, the chief consumers are England, Austria, Germany, and Holland. Sultanas are most in request in England, Holland, Belgium, and Germany. Of the entire quantity of raisins exported, on the average of the last five years, France has taken 38 per cent., England 24 per cent., Austria and Germany each 10 per cent., Italy and Russia each 3 per cent., and other countries 4 per cent. between them. The several descriptions of raisins appear in the market in an inverse order to their quality. The Yerlis come first, at the end of July; those from Vourlah, Phokes, and Chesmé about the middle of September; the Carabournons not till the end of September or beginning of October.

General Notes.

MARSEILLES MARITIME EXHIBITION.—The Paris *Moniteur Industriel* announces that the International Maritime Exhibition at Marseilles will be opened on the 15th instant, and remain open until April 31, 1884. Exhibits will not be received after October 31, except those from countries out of Europe, which will be admitted up to November 30. The programme is extensive, and on the whole embraces much the same range of subjects as the London Fisheries Exhibition.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 5...Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Discussion on "The Foot and Mouth Disease."

Society of Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. Weldon, "Note on the Influence of the Ammonia-Soda Process, or the Value of Hydrochloric Acid and Chlorine." 2. Mr. J. A. Wanklyn, "The Employment of Limed-Coal in Gas-making." 3. Dr. E. J. Mills, "The Examination of Fixed Oils."

Royal Institution, Albemarle-street, W., 5 p.m General Monthly Meeting.

Society of Engineers, Westminster Town-hall, Caxton-street, Westminster, 7½ p.m. Mr. Andrew Greig, "Dundee Street Improvements, and Drainage of Lochee."

British Architects, 9, Conduit-street, W., 8 p.m. President's Opening Address.

TUESDAY, Nov. 6.. Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Biblical Archeology, 9, Conduit-street, W., 8 p.m. 1. Mr. E. A. Budge, "The Fourth Tablet of the Creation Series relating to the Fight Between Marduk and Tiamat." 2. Mr. Theo. G. Pinches, "Babylonian Art, illustrated by Mr. H. Rassam's Latest Discoveries."

WEDNESDAY, Nov. 7...Geological, Burlington-house, W., 8 p.m. 1. Prof. T. G. Bonney, "The Geology of the South Devon Coast, from Tor Cross to Hope Cove." 2. Dr. J. Gwyn Jeffreys, "Notes on Brocchi's Collection of Subappenine Shells." 3. Mr. J. Starkie Gardner, "British Cretaceous Nuculidæ."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Messrs. J. J. Dobbie and G. G. Henderson, "The Classification and Properties of Red Resins known under the name of Dragon's Blood." 2. Professor Bayley Balfour will exhibit specimens of the Resin, and of the Tree brought by him from Socotra, and will make some remarks upon the plant and its affinities." 3. Professor Redwood, "The Preparation of Lard for Use in Pharmacy."

THURSDAY, Nov. 8...Telegraph Engineers and Electricians, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Willoughby Smith (President), "Volta-electric Induction."

Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Mr. R. Tucker, "Symmedians and the Triplicate Ratio Circle." 2. Capt. P. A. Macmahon, "Symmetric Functions, and, in particular, certain inverse operators in connection therewith." 3. Professor Wolstenholme, "A Certain Envelope." 4. Mr. R. A. Roberts, "Certain Results obtained by means of the Arguments of Points on a Plane Curve." 5. Mr. E. B. Elliott, "Third paper on Frullanian Multiple Integrals."

SATURDAY, Nov. 10....Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. D. J. Blaikley, "Some Experiments on the Velocity of Sound in Air." 2. Mr. R. H. M. Bosanquet, "The Moment of a Compound Magnet." 3. Mr. W. L. Carpenter, "Measurements relating to the Electric Resistance of the Skin, and to certain Medico-Electric Appliances."

Journal of the Society of Arts.

No. 1,616. Vol. XXXII.

FRIDAY, NOVEMBER 9, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Thirtieth Session of the Society will be held on Wednesday, the 21st November, when the Opening Address will be delivered by Sir William Siemens, D.C.L., LL.D., F.R.S., Chairman of the Council. Previous to Christmas there will be Four Ordinary Meetings, in addition to the Opening Meeting.

Candidates proposed for election as members are privileged to attend the Opening Meeting.

Ordinary Meetings.

The following papers (among others) will be read:—

"The International Fisheries Exhibition of 1883." By A. J. R. Trendell, of the Inner Temple, Barrister-at-Law.

"The Manufacture of Mineral Waters." By Thomas T. P. Bruce Warren.

"Coal Gas as a Labour-saving Agent in Mechanical Trades." By Thomas Fletcher, F.C.S.

"The Progress of Electric Lighting." By W. H. Preece, F.R.S.

"Forest Administration in India." By Dr. Brandis.

"Electric Launches." By A. Reckenzaun.

"Science Teaching in Elementary Schools." By William Lant Carpenter, B.A., B.Sc.

"Cupro-Ammonium Solution and its Use in Waterproofing Paper and Vegetable Tissues." By C. R. Alder Wright, F.R.S., D.Sc.

"The Upper Thames as a Source of Water Supply." By Dr. Percy F. Frankland.

"Historical Development of the Different Settlement Systems of British India." (Second Communication.) By W. G. Pedder.

"Canada as it will be seen by the British Association in 1884." By Joseph G. Colmer, Secretary to the High Commissioner for Canada.

"Telpherage." By Professor Fleeming Jenkin, F.R.S.

Foreign and Colonial Section.

The Meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock:—

January 29; February 26; March 18; April 1, 29 May 20.

Applied Chemistry and Physics Section.

The meetings of this Section will take place on the following Thursday evenings, at Eight o'clock:—

January 24 February 21; March 27; April 24; May 8, 29.

Indian Section.

The meetings of this Section will take place on the following Friday evenings, at Eight o'clock:—

February 15; March 7, 28; April 25; May 9, 30

Cantor Lectures.

The First Course will be on "The Scientific Basis of Cookery." By W. Mattieu Williams, F.C.S.

December 3, 10, 17.

The Second Course will be on "Recent Improvements in Photo-Mechanical Printing Methods." By Thomas Bolas, F.C.S.

January 28; February 4, 11.

The Third Course will be on "London Houses." By Robert W. Edis, F.R.S.

February 18, 25; March 3.

The Fourth Course will be on "The Alloys used for Coinage." By Prof. W. Chandler Roberts, F.R.S., Chemist of the Royal Mint.

March 17, 24, 31; April 7.

The Fifth Course will be on "Some New Optical Instruments and Arrangements." By J. Norman Lockyer, F.R.S., F.R.A.S.

April 28; May 5.

The Sixth Course will be on "Fermentation

and Distillation." By Professor W. Noel Hartley, F.C.S.

May 12, 19, 26.

Juvenile Lectures.

The two Juvenile Lectures will be by J. Miller Thomson, F.R.S.E., F.C.S., Lecturer on Chemistry at King's College, London, on "Crystals and Crystallisation." The dates for these lectures are Wednesday evenings, the 2nd and 9th January. Special tickets will be issued for these lectures, due announcement of which will be made.

Proceedings of the Society.

CANTOR LECTURES.

ON SECONDARY BATTERIES AND THE ELECTRICAL STORAGE OF ENERGY.

By Professor Oliver Lodge, M.A., D.Sc.

Lecture II.—Monday, May 28th, 1883.

I must now say a few words about the methods and instruments for practically measuring the various quantities involved in the storage of energy by secondary batteries. We need current or ampère-meters, potential or volt-meters, quantity or coulomb-meters, and energy or erg-meters. The well-known dead-beat am-meters and volt-meters of Professors Ayrton and Perry are exceedingly convenient instruments, especially the former; the only objection to them is the frequent calibration they require, because their permanent magnet changes in strength. When portability is not essential, I find a high-resistance galvanometer, of the form known on the continent as the "Wiedemann," a most accurate and convenient volt-meter. The needle has a thick copper damper, which makes it almost dead-beat, and a resistance of 30,000 ohms or so has to be added to the circuit, in order to bring the deflection given by one cell within moderate range. It thus taps off an absolutely infinitesimal fraction of the current.

The deflections are immediately interpreted by observing, at the same time, the reading produced by a couple of common Daniell cells in series, each of these being assumed to be 1.12 volts. There is a trifle of uncertainty about the absolute E.M.F. of even a freshly set up Daniell, and this uncertainty will continue until an authoritative standard of E.M.F. is issued by the British Association Standards Committee; but variations in E.M.F., one-thousandth part of the whole, can be readily detected; and a sensitive volt-meter is somewhat important, if fouling cells are to be detected in their early stages, and before the cell is seriously injured.

As a meter for the quantity of electricity supplied or withdrawn to the cells, I use a large copper drum, suspended in sulphate of copper on the end of a balance arm, in such a way that it can be weighed at any moment without withdrawing it from the solution. Contact is easily made with it by means of mercury, and it is surrounded with a larger cylinder of copper, to act as the other pole. Allowing for the buoyancy of the solution in which it is weighed, every gramme increase or diminution of the drum means 1·04 ampère-hours put into or taken out of the cells. Frequent weighings of the drum enable one to get a very good idea of the cells as regards charge, and they keep an accurate record of the loss, or discrepancy between the charge and discharge quantity.

A copper-drum coulomb-meter may also be made floating, so as to indicate by its height the quantity of electricity which has passed through. If such a vertical-moving quantity indicator carries a sheet of sensitised paper, on which the horizontal moving spot of light from a volt-meter records a trace, the arrangement will give an indicator diagram of the charge and discharge precisely analogous to the indicator diagram for the steam-engine, except that the area enclosed by the curve represents the loss of work instead of the balance of useful work. The useful work is indicated by the area between the discharge curve and the two straight lines of reference.

Many plans can be devised for combining the two traces, the quantity and the E.M.F., at right angles to one another, and the continued use of some such instrument would, I believe, assist in detecting the peculiarities of cells, and in improving their manufacture and system of treatment, almost to the same extent as the indicator throws light on the peculiarities of different steam-engines. But even without such an instrument for automatically constructing the diagrams, a curve plotted in this way (with quantity for abscissa and E.M.F. for ordinate) is the readiest mode of exhibiting the results of measurement taken with ordinary meters, and making the value of the cell manifest at a glance.

A highly ingenious quantity-meter has been devised by Dr. Hopkinson, and since it indicates precisely like a gas-meter, it is easily intelligible, and may come into general use. But at the present, I believe, it only works one way, hence it is not so directly applicable to secondary batteries; it would add up both charge and discharge in one continuous record, drawing no distinction between them. The simplest power or watt-meter is the Siemens dynamometer, arranged with one series and one shunt-coil; and it indicates at any instant the power which is being supplied or withdrawn from the cells.

An erg-meter, or energy-integrator, can be made in various forms. The one I have here to show is Ayrton and Perry's modification of an eight-day clock. They substitute a fine coil of wire for the bob of the pendulum, and surround this with another larger and thick coil. A current sent in the same direction round two nearly concentric coils, causes the smaller one to move to the centre of the large one. Thus, if the pendulum is oscillating, and the clock keeping good time, a current sent round the two coils will cause the clock either to gain or lose, according as the currents are opposed or agree in direction. If the two coils are both in series in the circuit, the gain or loss of the clock will indicate the coulombs passed through. But if the small fine coil is a shunt, while the other is a series, the force acting on the bob will be a function of the power, and the gain or loss of the clock will indicate the energy in some more or less arbitrary way, which can be made simple proportion by empirically adjusting the relations among the parts.

To determine the internal resistance of a battery cell, or of a whole battery, the plan is to measure its electromotive force when driving two different strengths of current, as different as possible and both known, One strength of current is most conveniently zero; the other must be measured, say, by an am-meter in the circuit. A volt-meter, such as the high resistance Wiedemann, is connected to the terminals of the battery, and read. Its indication will be a scrap higher if the current was being supplied by the cells, but lower if the current was being supplied to them. The difference of the indication of the volt-meter, when a current is passing, and when no current is passing, is proportioned to the resistance of the battery, and for a secondary battery cell in good order, the difference is surprisingly small, so much so that an ordinary volt-meter will often fail to detect it. To get the resistance of the battery in ohms, you must divide the difference in the readings of the volt-meter (interpreted into volts) by the strength of the current passing in the main circuit, reckoned in ampères. A moment's interruption is sufficient with a good dead-beat volt-meter, and the current may be immediately switched on again before the disturbance in the circuit has had time to show itself, except indeed where the current is being used for lighting purposes, in which case no tricks may be played unless there are several batteries in multiple arc, and one of them can be disconnected without detriment. This, indeed, is a good plan of connecting batteries, as it allows measurements, examinations, and repairs to go on while the current is being used. The resistance of one of the small sized (half horse-power-hour) cells with nine pair of plates averages ·002 ohm. Large cells have a still lower resistance, of course, and it is to this extremely low internal resistance that the secondary battery owes much of its great practical value. The current from an ordinary Grove's battery is by no means proportionate to the external resistance of the circuit unless this is high; in other words, the driving power of a cell, or the difference of potential between its terminals, falls off greatly when strong currents are demanded. But a secondary battery, from its enormous area of surface, not only gives a higher E.M.F. than a Grove ever does, but it keeps this two volts difference of potential between its terminals for pretty nearly any reasonable strength of current Hence the current does within wide limits vary with the external resistance, and the current which such a cell will drive through a piece of thick copper wire is simply tremendous.

I must now say a few words about the uses to which secondary batteries can be applied; and, first of all, for general laboratory purposes they are invaluable. A small gas-engine and shunt-dynamo are necessary to charge them up occasionally, but they then retain their charge for days or weeks, according to the demand made upon them, and they are ready at any moment to produce a current, strong or weak, according to wish. They thus save a deal of trouble in setting up Grove batteries, and, moreover, the current they give is much steadier, for unless they are run to near their falling-off point, their E.M.F. continues very constant, and no compunction is felt at leaving them connected up to the circuit for a long time together—for such a time as would make

Grove-cells heat violently and boil over. When they are run down, a few days' charging replenishes them again.

As regards durability, the cells repay cleanliness and attention. I mount them in front of a window, on a slab of thick glass raised above the bench, one can then see all over and through them, the light being reflected from below the glass slab by an inclined bit of looking-glass which can be moved about It ought also to be possible to get on both sides of the bench, so as to be able to detect and remove any attempt at contact between the plates of a cell.

If a lump of composition tumble out and bridges across from one plate to the next, it can be removed with a paper-knife. Plenty of light, easy access, and clear vision through between the plates of each cell are highly desirable. The glass cells and the slab should also be kept clean, and free from acid splashes and spray, for all this moisture promotes leakage, and causes the cells to lose their charge more rapidly than they would by ordinary and unavoidable local action.

When cells are stowed away in dirty dark cellars, on wooden shelves, like wine bottles, the leakage must often be considerable, and the cells may get into any state of dilapidation without detection, or attempt at remedy. A light attic, or glass house, with crockery slabs at a convenient height, is a much more suitable place for secondary batteries than a wine cellar.

It is important to be able to detect an incipient flaw in a cell before it has had time to damage the cell perceptibly. A sensitive voltmeter may do this, but an ordinary one will not show any difference for a long time, and if the cell is in series with others, as soon as it begins to run down in E.M.F., the others rush it down to, and past zero, and begin to charge it up wrong way. This reversal is very bad for a cell, besides its very weakening effect upon the main current. It is very important to keep all the cells of a series as exactly alike as possible. A bad short circuit often causes a hissing noise which can be heard with a stethoscope applied to the cell, even when it is not loud enough to call your attention, as it sometimes is. But the most delicate detector of an incipient short circuit is the thermometer. All the cells heat by their proper current, but any abnormal action going on in a cell, whether it be short current or local action, or any other dissipation of energy, must result in heat, and the thermometer is the natural detector of this. Any cell warmer than the others should be examined, and set right, or else replaced.

The lugs and contacts should be wiped clean occasionally from the acid spray which collects on them, and they may also be recoated with paraffin and shellac. This acid spray is thrown up by the bubbles of gas which rise when the cell is getting full. The hydrogen bubbles throw up largish globules, which bound two or three inches into the air, and fall all over the slab and terminals; but when hydrogen comes off freely, the cell is commonly quite full. The oxygen which comes off slightly during the greater part of the charging, throws up much more minute globules, which float about as an acid spray, very irritating to the nostrils and very provocative of leakage. The spray may be greatly diminished by a layer of oil spread over the surface, in which the bubbles collect and break in a different way, and it also checks evaporation; but the oil introduces difficulties of its own when the plates have to be lifted out of the cell, though indeed it may be first flooded off. The contacts of the positive plates are very apt to be corroded by the spray and creeping film, together with the per-oxidising action of the current crawling up wet lugs, and they require occasional attention. Unless absolute uniformity of contact is secured, some of the plates will take nearly all the current, and get peroxidised to pieces, while the others are nearly idle.

I use pans of very dilute ammonia, or perforated boxes of carbonate, to neutralise the acid spray. The atmosphere is then much improved, and instead of acid films, white crusts of ammonia sulphate collect, which are less harmful, and may be cleared off. Another precaution is always to keep the cells filled with acid above the level of the plates, so that they are completely immersed, else the part above the liquid will be exposed to the influence of non-concentrated acid, from the evaporation of the water out of the acid film covering it. It is important to remember that all these exposed layers of acid are likely to become pretty concentrated, and hence, that they may be expected to corrode more rapidly than the mass of the solution.

Another advisable precaution is to stir or agitate the liquid occasionally, more particularly during charging. The bubbles of gas, fortunately, do this to some extent, if the cells are well filled up electrically; but if no such agitation is excited, the acid at the bottom of the cell is apt to become very much more

concentrated than that at the top. Not that gravity is able to pull down strong acid out of once thoroughly mixed dilute acid. Gravity cannot undo diffusion like this. But it is the acid freshly formed during re-charging, by decomposition of the sulphate of lead on both plates—it is this acid which falls to the bottom and accumulates there, frequently corroding the bottoms of the plates. One great advantage of the present cells over the old flannel-swathed Faure, is that they permit free circulation of the liquid. To make the cells answer various laboratory requirements, I have a sort of resistance-box, made with uncovered spirals of German silver wire, in a stoneware water trough, so that the wires do not melt, and I can then throw in any resistance from a quarter ohm upwards, otherwise the current would be frequently too strong. For working a Serrin lamp no extra resistance is necessary, and from eighteen to twenty-two cells work it admirably. Even when one drives the lamp direct from the dynamo, the battery is still connected as a shunt circuit, to act as a regulator and steady the current. Moreover, it has the great advantage of preventing the engine from racing away when one puts out the lamp. A well governed engine, of course, ought not to do this in any case, but I have not found a gas-engine behave well, when work is thrown on and off it in such an irregular and fitful manner as a lamp is commonly used in a lecture. It is much better for it to be pumping into the cells whenever the lamp is put out. Moreover, one can get a far more powerful current through the lamp in this way than from a small dynamo direct. Another advantage of having the battery connected is, that it will not permit the locking of the carbons, and thus the short circuiting of the field magnets of the shunt dynamo, which is a not infrequent occurrence when a shunt dynamo alone is used to feed an arc lamp.

If, however, only a regulator is wanted, and not a store of energy, a set of zinc and lead plates can be easily arranged, which will do all that is wanted in the way of regulation; and as the lead gets gradually more and more "formed," the battery will gradually acquire more and more actual storage capacity. The cells were very useful once when the gas-engine was being repaired. I took the dynamo over to a neighbouring steam-engine, and laid its comparatively full current with spans of common wire to the battery. From the battery thus charged, the powerful occasional currents needed for some magnetic researches then going on were readily obtained. To bring such currents from the distant dynamo would have necessitated the use of very thick and expensive cable, and would in fact have seriously damaged its armature.

The battery thus acted as a transmuter of weak currents into strong ones, and this illustrates on a small scale one of its very important future functions, viz., a receiver of energy transmitted from a distance, as Sir Wm. Thomson has pointed out. Currents generated at a distant station, to be conveyed to a distance, ought not to be strong; they ought to be feeble currents at a high potential. They can be received by a great number of batteries in series, and the batteries so charged can be used for any local purposes, and made to give any reasonable desired current by altering their connections. Moreover, they can be coupled up to a number of independent circuits, so that irregularities in one shall not interfere with the others. The great advantage of a set of batteries as a receiver, over a set of dynamos in series, is that the latter would need such a high internal resistance to give the necessary back E.M.F., whereas a battery, even of small cells, can give 1,000 volts E.M.F., with an internal resistance of only 2 ohms. Hence the waste in heating the receiver is next to nothing. There is another kind of waste, no doubt, for the work got out of a battery can never be anything like that put in. The E.M.F. of charge is about 2·3 or even 2·4 volts, while that of discharge is scarcely above 2; besides this, there is a slight loss or discrepancy between the quantity supplied and that afterwards withdrawn. Notwithstanding this waste, they must come into use when made in a satisfactory and quite dependable manner, for their great convenience and steadiness. And when the power at the distant station is water or wind-power, as I doubt not it often will be, waste becomes of secondary importance, and a convenient method of storing is the first consideration.

So plainly is high E.M.F. pointed at as the requisite for the economical transmission of energy, that I cannot help thinking that, in some cases, a use will be found for electrostatic machines as generators instead of dynamos. Not exactly a Holtz machine—which has a high internal resistance, and must dissipate energy, from its use of non-conductors and sparking intervals—but some gigantic form of Thomson's replenisher with metallic contacts. A large machine is needed to give

a current of one ampère, but not outrageously large, and a clear separation of the parts by a millimetre will enable 4,000 volts E.M.F. to be obtained. No great horse-power is here represented, but it would be transmitted by a well insulated wire with very small loss.

In using a waterfall running continuously to light a town for, say, eight hours, batteries are evidently desirable. Three sets might be used, each charging for eight hours—one or other of them always charging, and two of them discharging during the eight hours the light is required. Or two sets would be sufficient if the water-power itself could be used for lighting direct. But the use of three sets of batteries would enable a reasonably distant waterfall to be used, and would, for the eight hours the light is needed, give an actually greater horse-power than the fall itself possesses.

For locomotion in cases where the current cannot easily be supplied to the moving carriage by metallic conduction, as in tram-cars on common streets, batteries carried by the tram-car afford an obvious, and, moreover, an economical form of motive power. It is sincerely to be hoped that electric tram-cars may speedily come to perfection, and that the excessive wear and tear of horseflesh in this monotonous and severe labour may be checked.

[A number of motors were exhibited, some lent by the Electrical Power Storage Company, and some by Professors Ayrton and Perry. A De Meritens motor, driven by 18 storage cells, was used to drive a small Siemens's dynamo by a strap, the current from this being used to drive another motor, which worked a lathe, or was used to light four small Swan lamps. A Pilsen arc-lamp was shown, working very steadily with the current from the battery, and a number of Swan lamps were also excited, so as to show how entirely any one was unaffected by the turning out of the others, a battery behaving in this respect like a very good compound wound dynamo. Diagrams of the mode of connecting up cells and dynamos for transmission of power and curves representing the charge and discharge of cells, as tested by Dr. Hopkinson and Messrs. Ayrton and Perry, were also exhibited, but it is thought unnecessary to reproduce them here.]

For driving boats electrically, secondary batteries are obviously necessary, because the laying on of a current by a wire is not only inconvenient but impossible. The storage cells will act as ballast, and can be charged while the boat is moored. For swift short voyages, and for pleasure vessels, nothing better than electrical propulsion is likely to be devised. For long voyages and big ships, the weight of secondary batteries would need all the floating power the ship possesses, and perhaps more. The energy consumed in propelling the present Atlantic liners is something almost incredible.

When motors are driven by secondary batteries with very short connecting wire, the question arises, is high E.M.F. still desirable, as it is when transmission across great distances is concerned, or may powerful currents be now used with advantage? The answer is that, neglecting the resistance of battery and connecting wires, there is neither gain nor loss in using powerful currents, provided the dynamo is properly wound, and has brushes that will not burn up.

But if we do not neglect the resistance of the batteries—a thing we have no right whatever to do—the answer is, that high E.M.F. is of very great advantage. A large number of cells in series, driving a high E.M.F. dynamo at its highest possible speed, and with as small a current as is needed for the power, is by far the most economical arrangement. Now, a screw for a ship has always needed a high speed for economy, and in the old days gearing used to be employed between the steam-engine and the screw, because no high-speed engine was sufficiently economical. I understand that slow engines are still the best, but the disadvantages of gearing are so great that high-speed direct-acting engines are always used. But a high speed is absolutely essential to economy in an electric motor, and no screw, as ordinarily made, would work at such a speed; consequently there is a temptation to use gearing the other way, and to gear down the dynamo to suit the screw. I hope the attempt will be resisted, and high-speed screws made of small size, smooth surfaces, and low pitch, so that the electric motor axle may be coupled direct to the screw shaft. The direct rotatory action of a dynamo used as a motor, as opposed to the oscillating action of a steam-engine, is a great simplifier of mechanism, and will be found extremely convenient.

For all kinds of short transit locomotion, electric power will, probably, prove to be the most suitable, and the improvement in the atmosphere of the Underground Railway which would result from the adoption of such a means of propulsion, would be far more remarkable than anything which ventilators, whether

ornamental or the contrary, are able to effect. In fact, there can be little doubt that the practical development of electrical appliances in the near future will be something extraordinary, and the consequence of this, and of the extensive use of gaseous fuel, will be, I most sincerely hope, and not unreasonably believe, not only the abatement, but the compulsory abolition, of smoke and all other artificial pollution of the atmosphere, and such an improvement in the air of towns as will change them from stifling purgatories into wholesome and refreshing centres of life and work.

Miscellaneous.

SILK INDUSTRY OF THE WORLD.

An American Consular report on this subject, by Consul Peixotto, of Lyons, has lately been published, and from it have been taken the following particulars:—

France.—The silk manufactures of Lyons occupy, in the city proper and contiguous departments, upwards of 120,000 looms, about 20,000 being power looms; and the production of silk stuffs, amounting annually to about 80,000,000 dols., 30,000,000 dols. of which are mixed goods—silk and cotton, silk and wool, silk and linen, &c.

Belgium.—At Antwerp very excellent goods are produced, but in general Belgium's production of silk goods is extremely limited.

Switzerland.—Silk manufactures were originally introduced by weavers from Lyons. Religious persecutions drove many of the workmen of the Silkopolis to the land of William Tell. In 1855 she had about 25,000 looms. In 1882 she possessed upwards of 40,000, more than 4,000 of which are power looms, while her production of silk goods amounts to from 16,000,000 dols. to 18,000,000 dols. Zurich is the principal manufacturer of broad goods; Basle of ribbons. Switzerland exported to the United States in 1881, from Zurich alone, over 4,000,000 dols. worth of silk goods, increasing the figure by 450,000 dols. last year. Zurich produces for the most part plain goods, black and coloured; recently, however, she has been remarkably successful in armures, satins, serges, and marcelines. Basle has become the great competitor of St. Etienne, and with the United States has all but annihilated the once famous capital of the Loire. Labour forms but a fourth of the cost of production in Switzerland; in France it is nearly a third.

Germany.—Silk manufactures were first introduced in the sixteenth century. French weavers driven from France again appear as the principal founders. The Rhine provinces and Brandenburg became the centres of silk weaving. In later years the development has been extraordinary. In 1882, the number of looms in Germany was estimated at 75,000 to 90,000. At Crefeld there were 35,000 to to 40,000 looms. In 1881, the production of that place alone was 20,000,000 dols. The total production of Germany is fixed at 45,000,000 dols., without including ribbons, of which about 8,000,000 dols. to 10,000,000 dols. worth are manufactured. Crefeld has at present 25,000 to 30,000 looms devoted to velvet, and from 45,000 to 50,000 looms altogether. In ordinary seasons, the silk manufacturing interest of Germany is divided into two-fifths for velvets, three-fifths for all other varieties. For the past two years this proportion has been reversed. Crefeld, Elberfeld, Barmen, Virsen, Mulheim, &c., are the chief towns devoted to this industry. There are upwards of one hundred and forty manufacturers located at Crefeld out of the 300 which Germany is reputed to possess. Mr. Peixotto says that it is incontestable Germany has beaten France and all other countries in the last five years in the production of that class of silk goods which enter so largely into popular consumption. If she once imitated other countries, and particularly her great rival France, she to-day manufactures quite as original designs, which, if still lacking in that exquisite taste for which Lyons is justly celebrated, are sufficiently varied to please and find large consumption. To the manner of living of the German weaver, his domestic habits and working, his regular hours and regular work for the same manufacturer, and to the custom of the manufacturer himself in buying the raw material on from six to nine months' time, to his ready adoption of new devices and new inventions, must largely be ascribed the wonderful success of the Teutonic silk manufacturer.

Saxony.—In recent years there has been a remarkable development of silk manufactures in the little but ever industrious kingdom of Saxony. The liberal introduction of machinery has greatly contributed to this result. There are a number of factories which possess from 800 to 1,000 looms.

Austria.—The chief centres of the Austrian silk manufacture are in the provinces of Bohemia and Moravia. Around Vienna are clustered factories which produce only the finest tissues. Nearly every variety of silk goods are manufactured. The average weekly wages of ordinary weavers range from 1·15 dols. to 1·30 dols.; expert weavers in fine goods earn from 4 dols. to 6 dols. per week. Austrian manufacturers copy and produce, with remarkable fidelity, the goods of Macclesfield, Zurich, Crefeld, and even approaching those of Lyons. About 15,000 to 20,000 looms, of which 3,000 are power looms, are employed. The total production of silk goods is estimated at from 10,000,000 dols. to 15,000,000 dols. Formerly, Austria-Hungary was one of the best customers of Lyons; but, like Germany, this country has reduced her importations from France to significant figures.

Italy.—For many centuries Italy enjoyed the monopoly for the manufacture of silk goods. At present, such cities as Genoa (celebrated at all times for its velvets), Florence, Milan, Como, Venice, Naples, Bologna, Turin, &c., scarcely possess in total more than 30,000 looms; and Como is among the largest places of production. It is estimated that the Italian manufactures of silk stuffs amount to from 10,000 dols. to 12,000,000 dols.

Spain.—The Moors brought, with many other contributions, silk manufactures into Spain. In the ninth century, Spain already produced stuffs of silk and gold, celebrated for the beauty and costliness of their manufacture. In the past, Murcia, Valencia, Saragossa, and a few other districts, were the centres of this industry. To-day, Barcelona is pre-eminently the great manufacturing district for Spanish silk. In the absence of official statistics it is estimated that there are 10,000 to 12,000 looms, producing from 6,000,000 dols. to 8,000,000 dols. annually of silk goods.

Russia was formerly a very large consumer of the silks of France. Later on, she took from Lyons not only workmen, but a number of very important matters in the art of weaving. Now Russia produces for herself the majority of silk goods which she consumes; the costly silks of French manufacture she still, however, takes fair quantities of. The total production of silk tissues may be calculated at 16,000,000 dols.

Great Britain.—In 1829, England numbered 50,000 looms; in 1855, 110,000; and in 1860, 150,000. The production was then estimated, including every variety of goods into which silk entered as a component part, at 60,000,000 dols., but it is probable that this figure was exaggerated. Great has been the decay of this industry since then; and since the French treaty of commerce of 1880 England's silk prosperity has fallen constantly. In 1872 she possessed about 65,000 looms, 12,378 of which were power. The imports of silk goods in that year into England are given at 44,000,000 dols. From all the evidence Mr. Peixotto could obtain he places the present production of silk goods in England (not including ribbons and bindings) at 22,000,000 dols. to 25,000,000 dols. England excels particularly in plush velvets, crapes, surahs, moire-antiques, umbrella silks, ribbons, galoons, handkerchiefs, cravats, and goods of silk mixtures. The principal centres of silk manufactures are: for broad goods, Manchester, Macclesfield, Bradford, and Spitalfields; for marcelines, Macclesfield; for crapes, Norwich; for taffetas, Manchester and Macclesfield; for velvets, Bradford and Manchester; for ribbons, Coventry and Nottingham; for figured silks (faconnés), Bradford, Manchester, and Macclesfield; for handkerchiefs, &c., Glasgow and Manchester.

United States.—Mr. Peixotto writes, "Twenty odd years of high protecting duties, averaging fully 50 per cent., and for at least a fourth, if not a third, of our exports as high as 60 per cent., has largely contributed to build up our silk manufactures, whose total annual production (including all varieties of goods) may safely be fixed, at present, at from 35,000,000 dols. to 38,000,000 dols. Probably not more than 15,000,000 dols., if that, come into direct competition with the piece goods fabrication of Europe. . . . In the near future, it will more than ever be to the genius of American invention, and its application, that the United States will keep what she has already acquired, and become one of the richest silk producing and silk manufacturing countries of the globe."

China.—Though official statistics are lacking, the most trustworthy authorities fix the number of looms in China at 350,000; the production of silk stuffs at 60,000,000 dols. to 65,000,000 dols.; of which 6,000,000 dols. to 7,000,000 dols. worth are exported. There is no country where silk fabrics are so generally and so largely consumed as in China; no country which produces such varied and brilliant colours, and such variety and peculiarity of goods. The wealthy classes not only dress entirely in silk, but furnish every part of their habitation with this lovely and beautiful textile. The sobriety and economy of the Chinese is proverbial. The wages earned are utterly insignificant in comparison with European and American labour, A reeler of silk is happy to gain 6 cents per diem, a weaver 15 to 20 cents, or 25 cents. A thousand years have scarcely wrought any changes. What the introduction of automatic machinery would accomplish no words can tell. With her wonderful harvest of the raw material, of which scarcely more than 90,000 bales are exported, the introduction of modern machinery would completely transform this industry, which at present rests in very near the same state as in the time of Confucius.

Japan.—Official statistics are wanting also in Japan; and even those who have lived long in the country furnish contradictory reports. From the best authorities (personal as well as from commercial reports) Mr. Peixotto fixes the figure of looms at 222,000. The production is almost entirely consumed at home, the export of manufactured silks being still inconsiderable.

India.—There are probably not more than 3,000 to 4,000 looms in India, producing annually from 800,000 dols. to 1,000,000 dols. worth of silk goods. These tissues are made from the native silks, called Corah and Tusser. Mr. Peixotto is personally acquainted with a Lyons house which sells about 200,000 dols. of the silk products of India. The production of silk amounts to about 22,000 bales annually, which may be valued, in round figures, at 7,000,000 dols.; 6,000 bales of which are shipped to France and England.

Syria and Asia Minor.—Twelve thousand looms, with a production of from 4,000,000 dols. to 5,000,000 dols. of manufactured stuffs. Very good silk is also produced from the cocoons raised.

Total Production.—The total production of silk

goods in the world may be estimated at about 350,000,000 dols. Deducting the manufactures of China and Japan, whose economical situation is so very different from other countries, there remain 270,000,000 dols. worth of silk manufactures, which may be divided among different countries, taking the maximum as follows :—

	dols.
France	85,000,000
Germany	45,000,000
United States	35,000,000
Great Britain	25,000,000
Switzerland	18,000,000
Russia	16,000,000
Austria	12,000,000
Italy	12,000,000
Spain	5,000,000
Other countries	17,000,000
Grand total	270,000,000

Mr. Peixotto estimates 470,000 as the number of looms employed in the silk goods production, including power looms, which thus explains the difference, for if hand looms were alone used, the number would be very considerably greater.

The author says that his despatch is intended to present simply a *coup d'œil* of the silk manufactories of the world, and that he refers almost entirely to manufactured piece goods, ribbons, handkerchiefs, scarves, &c.

THE ROMAN FIRE BRIGADE.

Her Majesty's Secretary of Legation, at Rome, states that during the year 1882 there were 263 fires in Rome, but none of a serious character, no lives were lost, and three persons were rescued. Of this total number 133 fires were caused by chimneys, 5 by petroleum lamps, 53 were confined to the rooms in which they originated, 15 to ground floors, and the same number to shops, two mansions were burnt out, but no theatre took fire. The brigade is a civil body, but is organised under military discipline. It consists of a commandant, captain, doctor, sergeant engineer, bandmaster, and 12 other officers, 38 corporals, 8 trumpeters, 150 firemen on full pay, 120 on half pay, and 50 supernumeraries. The band consists of 40 men, who are exempt from day duty, but who are obliged to take their turn at night. The supernumeraries are on trial for admission to the corps when vacancies occur. The circuit of the fire brigade extends to a radius of two miles from the gates of the city. Its duties include attendance at all reviews and other functions at which the men may be ordered to attend, and they are bound to be present at all public festivals or spectacles where fires may occur. They must also give their services in all cases where their knowledge and experience render them useful, such as the fall of houses, &c. The doctor of the corps must be present at all the work of the brigade, so as to afford immediate medical aid in case of need. Instruction in telegraphy is obligatory for every member of the corps. For admission as supernumerary the candidate must be under twenty years of age, of good *physique* and character, not less than 1·60 metres in stature, knowing how to read and write, and working at some trade, art, or profession such as is calculated to fit him for the service of the fire brigade. Punishment consists in stoppages of pay from 50 centimes to 2 lire, and in heavier duties, in proportion to the offence. Grave misdeeds, however, entail suspension, degradation, or expulsion. A fund, consisting of fines, and of the payments made by private persons who have engaged the services of firemen at shows or theatres, is devoted to furnishing rewards for meritorious service. The uniforms of the men are provided at their own expense, each one paying a subscription of four lire per month for this purpose. Pensions are provided by a special fund to men who have served twenty-five years, and are fifty years of age. Compensations are also given in case of illness or loss of limbs incurred on duty, according to a fixed scale; widows and orphans are entitled to these pensions and compensations in case of the death of the head of the family. Acts of distinguished courage may be rewarded by counting a year of service towards pension, and two years in case of severe injury sustained in the accomplishment of deed of bravery. The fire brigade have the right to requisition, by force if necessary, any horses, to whomsoever they may belong, of which they have urgent need. An equitable payment is subsequently made for the use of the horses thus impressed. The pay of the men is as follows:—Commandant, 3,000 lire per annum (the lire being equivalent to about 9½d.); captain quartermaster, 2,400; sergeant engineer, 720; doctor, 1,200; bandmaster, 1,320; head farrier 1,080; head trumpeter, 600; two captains, 3,840; two lieutenants, 3,000; two sub-lieutenants, 2,040; four sergeants, 2,880; thirty-eight corporals, 22,800; eight trumpeters, 3,840; 150 men on full pay, 72,000; and 120 men on half-pay, 28,800; making in all a total of 150,120 lire, or £6,004 per annum.

THE MEXICAN TEXTILE INDUSTRY.

A statistical account, published by the *Colegio Gazette*, states that in addition to the manufactures of plain goods, the nine cotton printing establishments in Mexico produce together every year 400,000 pieces. It is said that the greater proportion of the printers and dyers employed in these factories consists of English workmen, who receive very good wages. The textile products of Mexico meet with a ready sale at remunerative prices. The cotton industry is said to be specially prosperous; this fact being likewise proved by the erection of new factories every year.

There are in Mexico ten woollen factories, producing cloths and dress goods. These are mostly in low qualities, the better grades being regularly imported from France and England.

Of silk factories there are as yet only few in Mexico, and those which are in existence are described as not being important. The principal centres of the silk industry are Puebla and Queretaro, but factories are also established at Aguas Calientes, San-Luis-de-Potosi, Guadalajara, Durango, Colima, Leon, Chihuahua, Jalapa, Saltillo, Monterey, Sinaloa.

The annual production of cotton yarn is valued at about 18,000,000 lbs. That quantity does not by any means suffice for the wants of the constantly increasing manufacture of cotton goods; this fact being illustrated by the extent of the yarn importations from England. It is remarked that England can deliver yarn in Mexico which has been spun out of American cotton, and can still compete with the productions of spinners who send yarn from the United States to Mexico. Although American spinners state that their English competitors use illegitimate means in connection with the weight of the yarn, it would seem, from the details quoted in the *Cologne Gazette*, that English yarn answers the requirements of the market, and is liked for its good packing. In a country where nearly all the transport of merchandise to the interior is effected by mules, goods have to be packed in very firm bales, or in cases. Thus the question of packing is of great importance, and will continue to be so until the railways now being constructed supplant the primitive systems of transport still in vogue.

MANUFACTURE OF SILK AT CREFELD.

The most notable feature of recent progress in the above industrial centre has been the introduction of power-loom weaving on such an increased scale of importance as to call for the first time for special mention in the statistical report of the Chamber of Commerce for 1882. The following return shows the relative position of hand and power-loom weaving at the close of last year:—

	Hand looms.	Power looms.
Piece velvets	17,812	299
Piece ribbons	541	72
Silk tissues	16,425	460
Ribbons	58	25
	34,836	856

As compared with 1880, the total number of looms of all descriptions showed an increase of 2,684.

The speciality of the district is the manufacture of mixed fabrics. The average relative proportions of the materials employed as compared to the total production of all classes of tissues is estimated as follows:—

	Per cent.
Silk	25 to 26
Schappe	15 to 16
Cotton	58 to 59

The value of the goods produced was in 1882 about £4,000,000 sterling, this amount being about 12½ per cent. in excess of the average of the two preceding years.

As might be supposed, Germany takes the largest quantity of any of the various markets in which Crefeld goods are sold, England ranking next; and the other countries of Europe following at a long distance behind. The exports to countries out of Europe is about equal to the trade done with England. The increase referred to in the total business done is caused by the expansion of domestic trade, and the augmented favour of German goods in France.

TINNED FOODS.

The *Medical Times* says that tinned meats, soups, vegetables, and more especially fruits, are all, without exception, contaminated by metals; such is the irresistible conclusions of recent scientific investigation. In 1878, Mr. Albert B. Menke communicated to the *Chemical News* results of analyses of a tin of lobster, one of apples, and another of pineapple; the latter contained tin dissolved in the juice equal to 1·3 grain per pound, the lobster and apples a much smaller quantity. Mr. Hehner in 1880 communicated to the *Analyst* the results of a prolonged and thorough investigation of the subject. He found tin in tinned French asparagus, American asparagus, peas, tomatoes, peaches, pineapples, white cherries, red cherries, marmalade, corned beef (five different brands), ox-cheek, ox-tongue (three kinds), collared-head, tripe, oysters, sardines preserved in oil, salmon, lobsters, shrimps, curried fowl (two kinds), boiled rabbit, boiled mutton, roast chicken, roast turkey, soup, and in three brands of condensed milk. The amount of tin found does not appear large—*e.g.*, in the milk one-tenth of a grain per pound, in one of the soups half a-grain per pound, and in a pound tin of preserved oysters seven-tenths of a grain per pound. On a later research, Mr. Wynter Blyth has found far larger quantities. In a recent report to the Vestry of St. Marylebone, detailing the examination of twenty-three samples of tinned apricots, tomatoes, pineapples, and cranberries, the amounts found, calculated as stannous hydrate, range from 1·9 grain to 14·3 grains per pound, the mean amount being 5·2 grains. The juice and fruit in some instances had a metallic taste. Several of the tins showed signs of corrosion. The little that is known of the action of stannous hydrate may be summed up in a few lines. Doses of about ·174

gramme per kilogramme of body weight cause in guinea pigs death with signs of intestinal irritation; but with doses smaller than ·17 to ·2 gramme the effects are uncertain, and the animals generally recover. Hence, supposing a man to be affected in the same proportion, he would have to take from three to four drachms, or consume at a meal 10lb. of the most contaminated of Mr. Wynter Blyth's tinned fruits. But it is not a question of immediate deadliness; it is rather one for inquiry as to the action of small repeated doses continued for a long time.

Correspondence.

THE DWARF PALM (CHAMÆROPS).

This plant, referred to in the issue for Nov. 2nd, has some properties which I think are peculiar to itself, and although of no commercial value, they greatly increase its use for ornamental purposes. We have had one of these planted out in a drafty corner of a garden for three years without any protection; in one winter all the large leaves were broken down with the weight of snow accumulated on them, and that winter was exceptionally severe. It is almost the only plant which is absolutely uninjured by the fumes of burnt gas, and it will keep in perfect and robust health in badly lighted rooms in which gas is constantly used for lighting purposes. The plant which stood three years in the garden has been now standing twelve months on the floor of an entrance hall with a north aspect, and at some distance from the window; it has had no attention, except to occasionally wash the accumulated dirt or dust off the leaves, and is now as perfect and handsome a specimen as could be desired. It has stood, without injury, fourteen years of knocking about in an ordinary dwelling-house and garden, and thrives under the treatment. If its hardy nature were better known, it would become one of the most popular ornamental plants in existence.

THOS. FLETCHER.

General Notes.

BROMINE IN THE UNITED STATES.—According to a paper read before the American Pharmaceutical Association, the annual production of bromine in the United States amounts to from 450,000 to 500,000 lbs. It is obtained from the bittern of salt-wells—*i.e.* the residue after the salt has been removed from the brine—and in six localities named the bittern is so rich that for every two barrels of salt it yields one pound of bromine. The separation of bromine is said to be now carried on at all the brine works where it can be conducted profitably, and unless fresh deposits are discovered the production is more likely to decrease than increase.

EMBROIDERY INDUSTRY AT NANCY.—According to the German press, the embroidery industry of Nancy has lost much of its former importance; this manufacture having, thirty years ago, represented a yearly out-turn of £280,000 in value. The introduction of machinery was at one time expected to revive the industry, but has exercised a contrary effect, as many manufacturers who did not see their way to adopt the new style of work went out of the trade altogether. The value of the hand embroidery made at Nancy is said to be at present only £10,000 a year. A good part of the trade seems to have been transferred to certain districts in the Vosges, and in the arrondissement of Luneville, where labour is very cheap.

ELECTRICAL ACCUMULATORS.—The *Electrician* publishes an announcement that the Electrical Power Storage Company have effected some valuable improvements in the construction of their accumulators. In future boxes will be dispensed with, as also the metallic connections in the battery from cell to cell. The superficial area occupied by the accumulator is reduced to a minimum, and no doubt is entertained that the new type will be regarded by the public as adding greatly to the convenience and utility of electrical accumulators. The company hope that their factory will be able to turn out these accumulators by January next. In the meantime, unless in cases where it is absolutely necessary for the commencement of contracts, the company desire to withhold the supply of the present. The new construction will, we are informed, allow a reduction in the prices of the accumulator.

THE INSTITUTION OF CIVIL ENGINEERS.—The success which attended the course of lectures delivered this year has induced the council of the Institution of Civil Engineers to make arrangements for a similar series next session, the subject being "Heat in its Mechanical Application." The lectures will be delivered on Thursday evenings, at 8 p.m., in the months from November to April, as under:—(1883) November 15th—"The General Theory of Thermodynamics," by Professor Osborne Reynolds, F.R.S.; December 6th—"The Generation of Steam, and the Thermodynamic Problems Involved," by Mr. W. Anderson, M.Inst.C.E. (1884), January 17th—"The Steam Eugine," by Mr. E. A. Cowper, M.Inst.C.E.; February 21st—"Gas and Caloric Engines," by Professor Fleeming Jenkin, F.R.S.; March 20th—"Compressed Air and other Refrigerating Machinery," by Mr. A. C. Kirk, M.Inst.C.E.; April 3rd—"Heat Action of Explosives," by Capt.

Andrew Noble, F.R.S. Admission to these lectures will be as to the ordinary meetings of the Institution, that is to say, members, associates and students will have the right of personal admission, and every corporate member will have the privilege of introducing one friend.

CALCUTTA EXHIBITION.—The opening ceremony of the Exhibition is fixed to take place on Thursday, 4th December. The Exhibition will be open daily, except on Sundays, from 10.30 a.m. to 7.30 p.m., and from 8.30 p.m. to 11 p.m. Special arrangements will be made for the exclusive admission of native ladies on certain days. The jury regulations have been published. No exhibit will be allowed to compete for an award unless entered in the official catalogue. One-third of the jurors in each class will be elected by the foreign exhibitors, and one-third by the Indian exhibitors, the remainder being nominated by the Executive Committee. The jury will submit to the Committee signed reports, embodying the results of their examination of exhibits, and stating the specific reasons for each award. Reports and awards will be based upon inherent and comparative merit, the elements of merit being held to include considerations relating to originality, invention, discovery, utility, quality, skill, workmanship, fitness for the purpose intended, adaptation to public wants, economy, and cost. The jurors will classify the exhibits according to merit, without deciding as to the comparative merit of exhibits in the same class. The nature of the highest award to be given in each class will be decided by the executive. Certificates of merit in accordance with the award made by the jurors will be furnished to exhibitors by the Executive Committee. Silver and bronze medals will be given, as well as certificates of gold medals. These certificates will entitle the holders to receive gold medals on payment of their value, under an order signed by the President. The official business in this country in connection with the Exhibition is conducted by Messrs. J. M. Johnson and Sons, Limited, International Exhibition Offices, 1, Castle-street, Holborn.

ILLUMINATIVE POWER OF GASES.—In November last, Dr. Werner Siemens presented to the Berlin Academy of Sciences a paper from which it appears that gases heated to a temperature at which steel begins to melt, do not emit any luminous rays, if proper care has been taken to subject them only to heating and not to chemical action. Dr. W. Hittorf, of Münster, has since then recalled the fact that he made observations of this kind in 1879. When causing the electric spark produced by the 1,600 cells of his battery to pass between two platinum electrodes, he noticed the positive terminal surrounded by a yellow red light and the negative by a blue glow, but the rarefied gas between the terminals was quite dark, although hot enough to melt any metal rod held in it. Dr. Siemens' investigations induced Dr. Hittorf to repeat his experiments, employing two iridium bars (of equilateral section with a side of three millimetres and six centimetres long) from the well-known platinum works of Mr. Matthew. These iridium electrodes Dr. Hittorf fixed in strong brass rods and placed them opposite one another in a glass tube of six centimetres length. By arranging his powerful battery of 2,000 cells in groups so as to decrease the interior resistance, Dr. Hittorf obtained most beautiful and curious effects, the anode melting, and the cathode maintaining its sharp edges, both however at white heat, whilst the gases—nitrogen, hydrogen, and carbonic acid were experimented with —remained perfectly dark. From these experiments it would follow that wherever a gas is perceived to be glowing, we have to deal with a combustion or other chemical combination, and not with heat effects only; and it has been established by Mr. G. Wiedemann, that the splendid luminous phenomena of the Geissler tubes are of the nature of a phosphorescence, that is to say, of a slow combustion.—*Engineering.*

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 12...Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Opening address by the President, Mr. T. Smith-Woolley.

Royal Geographical, University of London, Burlington-gardens, W., 8.30 p.m. 1. The President's Opening Address. 2. Mr. H. H. Johnston, "The River Congo, from its Mouth to Bolobo, with Notes on the Physical Geography, Resources, and Prospects of the Region."

TUESDAY, Nov. 13...Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. George B. Bruce, Vice-President, will give a brief account of the Northern Pacific Railroad. 2. Mr. W. Hackney, "Standard Forms of Test-Pieces for Bars and Plates."

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. J. E. Price, "Exhibition of Peruvian Antiquities." 2. Prof. Flower, "A Deformed Skull of a Chimpanzee." 3. Mr. Edward Palmer, "Some Australian Tribes."

Royal Colonial, the Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Mr. Wilfred Powell, "New Guinea and the Western Pacific."

THURSDAY, Nov. 15...Linnean, Burlington-house, W., 8 p.m. 1. Mr. A. W. Bennett, "Reproduction of the Zygnemaceæ." 2. Mr. T. J. Briant, "Antennæ of Honey Bee, their Structure and Functions." 3, Mr. F. O. Bower, "Structural Peculiarities in the Stem of *Rhynchopetalum montanum*."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. C. O'Sullivan, "The Estimation of Starch." 2. Mr. G. Stillingfleet Johnson, "The Products of Decomposition of Solutions of Ammonium Nitrite."

Parkes Museum, Margaret-street, W., 8 p.m. Dr. Robert J. Lee, "The Disinfection of the Atmosphere."

Journal of the Society of Arts.

No. 1,617. Vol. XXXII.

FRIDAY, NOVEMBER 16, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

OPENING MEETING.

The First Meeting of the One Hundred and Thirtieth Session of the Society will be held on Wednesday, the 21st November.

The Committee regret to have to announce that, in consequence of the indisposition of Sir William Siemens, the Chairman of the Council, the delivery of the address, with which the Session is usually opened, has had to be postponed to a date to be fixed hereafter.

At the Opening Meeting, the chair will be taken by Sir Frederick Bramwell, F.R.S.

A Report from the Council as to the work of the coming Session will be presented.

ARRANGEMENTS FOR THE SESSION.

Previous to Christmas there will be Four Ordinary Meetings, in addition to the Opening Meeting.

Candidates proposed for election as members are privileged to attend the Opening Meeting.

Ordinary Meetings.

The following arrangements for the Wednesday evenings before Christmas have been made :—

Nov. 21.—Opening Meeting of the Session.

Nov. 28.—"The International Fisheries Exhibition of 1883." By A. J. R. Trendell, of the Inner Temple, Barrister-at-Law.

Dec. 5.—"The Manufacture of Mineral Waters." By Thomas T. P. Bruce Warren.

Dec. 12.—"Coal Gas as a Labour-saving Agent in Mechanical Trades." By Thomas Fletcher, F.C.S.

Dec. 19.—"Canada and its Products." By the Most Hon. the Marquis of Lorne, K.T., late Governor-General of Canada.

For Meetings after Christmas, the following papers (among others) will be read :—

"Sanitary Progress." By B. W. Richardson, M.D., F.R.S.

"The Progress of Electric Lighting." By W. H. Preece, F.R.S.

"Forest Administration in India." By Dr. Brandis, F.R.S.

"Electric Launches." By A. Reckenzaun.

"Science Teaching in Elementary Schools." By William Lant Carpenter, B.A., B.Sc.

"Cupro-Ammonium Solution and its Use in Waterproofing Paper and Vegetable Tissues." By C. R. Alder Wright, F.R.S., D.Sc.

"The Upper Thames as a Source of Water Supply." By Dr. Percy F. Frankland.

"Historical Development of the Different Settlement Systems of British India." (Second Communication.) By W. G. Pedder.

"Canada as it will be seen by the British Association in 1884." By Joseph G. Colmer, Secretary to the High Commissioner for Canada.

"Telpherage." By Professor Fleeming Jenkin, F.R.S.

"Water Regulation in England." By General Rundall.

Foreign and Colonial Section.

The Meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock :—

January 29; February 26; March 18; April 1, 29; May 20.

Applied Chemistry and Physics Section.

The meetings of this Section will take place on the following Thursday evenings, at Eight o'clock :—

January 24 February 21; March 27; April 24; May 8, 29.

Indian Section.

The meetings of this Section will take place on the following Friday evenings, at Eight o'clock :—

February 15; March 7, 28; April 25; May 9, 30

Cantor Lectures.

The First Course will be on "The Scientific

Basis of Cookery." By W. MATTIEU WILLIAMS, F.C.S.

December 3, 10, 17.

The Second Course will be on "Recent Improvements in Photo-Mechanical Printing Methods." By THOMAS BOLAS, F.C.S.

January 28; February 4, 11.

The Third Course will be on "The Building of London Houses." By ROBERT W. EDIS, F.S.A.

February 18, 25; March 3.

The Fourth Course will be on "The Alloys used for Coinage." By Prof. W. CHANDLER ROBERTS, F.R.S., Chemist of the Royal Mint.

March 17, 24, 31; April 7.

The Fifth Course will be on "Some New Optical Instruments and Arrangements." By J. NORMAN LOCKYER, F.R.S., F.R.A.S.

April 28; May 5.

The Sixth Course will be on "Fermentation and Distillation." By Professor W. NOEL HARTLEY, F.C.S.

May 12, 19, 26.

JUVENILE LECTURES.

The two Juvenile Lectures will be by J. MILLER THOMSON, F.R.S.E., F.C.S., Lecturer on Chemistry at King's College, London, on "Crystals and Crystallisation." The dates for these lectures are Wednesday evenings, the 2nd and 9th January. Special tickets will be issued for these lectures, due announcement of which will be made.

Correspondence.

WREXHAM SEWAGE.

I have just returned from Wrexham, where I had the gratification of assisting at the inauguration by the Mayor of the new tanks for the treatment of sewage, designed by Colonel Jones, and completed under his direction and supervision, as consulting engineer to the sanitary authority of that borough.

Almost from the commencement of his term, as lessee of the Hafod-y-Wern Sewage Farm, Colonel Jones had protested against the excessive dilution of the town sewage by rainfall, and had advocated the adoption of the separate system, wherever practicable, in order to palliate the mischiefs arising from sudden storms so prevalent in that district, and it was only in the course of the past year that the long-standing dispute, with regard to the precise import of the term "sewage," had been definitively adjusted. The particular mode of collection, and of disposal of sewage, will depend upon the local conditions of each town or district; nor is it pretended by Colonel Jones that the method adopted here can be regarded as a panacea for the evils of sewage pollution in every river-basin.

That which has been accomplished is most certainly applicable to the case of Wrexham and towns similarly circumstanced, and in that respect the eminent engineers gathered together for the occasion, were unanimous in their opinion that a notable advance had been made towards the solution of the much vexed sewage problem.

Mr. Osborne Morgan, M.P. for the County of Denbigh, spoke of it as a great triumph of the art of sanitation, deserving of all recognition and imitation throughout the kingdom; and Wrexham, to its great credit and renown, has set an example to other towns, which will not be without its influence upon the future of sanitation.

How many are still groping and drifting without compass or pilot to guide their course! To all such, Wrexham shines forth as a beacon light to point the way, and peradventure to stimulate the authorities in high places to a more decided course of action.

There may be found an excellent example of a combined system of deposition, broad irrigation, and intermittent filtration, each one the complement of the other, with a further protential advantage that, in the event of the irrigation farm passing away from the hands of the Corporation, they can adopt a system of chemical precipitation by means of these tanks, at a comparatively small cost, and upon their freehold, and thus obviate the dangers of pollution in the future.

By this means, Wrexham possesses, either in *esse* or in *posse*, an efficacious remedy against further contamination of the beautiful stream which flows through the town, whilst the riparian proprietors below, and more especially the city of Chester, have reason to be satisfied with the work done, and the motives which inspired it.

At least one tributary of the River Dee, from which the water supply of a large population is taken, has been rescued from destruction, and the dwellers upon the banks of that river—including even the Duke of Westminster himself—may be congratulated upon something actually achieved in these dark days of inertness, bewilderment, and stagnation.

At a Conference held at the Fisheries Exhibition a short while ago, the universal pollution of our rivers was stated to have assumed the proportions of "a national evil." Who indeed can gainsay it? *Si argumentum quæris, circumspice*, and this must be my excuse for inviting attention to an instance, I believe the first during the past two years, of a considerable step in advance gained, and

a truth vindicated, by a combination of engineering skill and tenacity of purpose with local energy, both loyally directed in the cause of sanitary progress.

C. N. CRESSWELL,

1, Hare-court, Temple,
Nov. 9, 1883

SOUR BEER.

A subject which I think is of considerable importance to brewers is what they are to do with sour beer-bottoms returned to them by beer retailers. In most parts of the country it has become impolitic to blend such sour beer with mild beer, as, from an experience of 36 years, I know was very generally done; but now beer-drinkers are become more particular in this respect, and prefer to drink ale without the addition of sour beer. Mr. Barclay (of the firm of Messrs. Barclay, Perkins and Co.) stated to the Committee of the House of Commons, in 1818, "that publicans require a certain quantity of this stale beer, which they mix with the mild beer according to the taste of their customers;" and, in answer to this question, "Is it absolutely necessary that a publican should have some of these remnants to mix for the taste of his customers?" replied, "I should think so. It has been the constant practice as long as I have known the trade, and in former years they used to draw more than they do now. The committee will see that, if the brewer had not this vent for selling his return beer, the price of beer must be considerably higher if he has to throw this beer away." It appears by this extract that, for the past 60 years and longer, this improved taste in the national beverage has been gaining ground, and year by year it will develop to a greater degree.

I write, therefore, in the hope of attention being given to this subject, and to elicit if there are any manufacturing processes for which acetic acid is necessary, which would afford a much better use for sour beer than blending it with mild beer.

A HAMPSHIRE BREWER.

Notes on Books.

ENERGY IN NATURE. By W. Lant Carpenter. London: Cassell and Co. 1883.

Under this title, Mr. Carpenter has re-published the substance of six lectures delivered by him in Lancashire for the Gilchrist Trust, the object of the work being "to give to those who have had little or no opportunity of studying the subject, some idea of the mutual relations existing between the various so-called 'Forces of Nature;'" or in other words, "to expound, in popular yet accurate language, the meaning and consequences of that important principle known as the 'conservation of energy.'" To this end the author begins with an explanation of the meaning of the term energy, showing the distinction between the two terms *energy* and *force*. In the first chapter, also, *matter* is defined, and the laws of motion stated and explained. Heat, as the commonest form of energy, is then dealt with; it is shown to arise from the retardation of destruction of mechanical energy. Joule's discoveries are described, and the mechanical equivalent of heat explained. The next chapter deals with chemical affinity; then come magnetism and electricity; this part of the subject affording abundant scope for illustration, by reference to the recent practical applications of electricity, especially to the dynamo machine, as used for the conversion of mechanical into electrical energy, and its reconversion into mechanical again. The concluding chapter of the book is devoted to "energy in organic nature;" the growth of plants, as dependent on the light and heat of the sun; the reproduction of this light and heat in combustion; the growth of animals dependent upon heat, &c.

OUR HOMES, AND HOW TO MAKE THEM HEALTHY. By R. Brudenell Carter, F. S. B. F. de Chaumont, W. H. Corfield, William Eassie, R. W. Edis, Rogers Field, Douglas Galton, F. Eccleston Gibb, Malcolm A. Morris, S. F. Murphy, J. W. Peggs, B. W. Richardson, P. Gordon Smith, W. Squire, K. D. Young, Phillis Browne. Edited by Shirley Forster Murphy. London: Cassell and Company. 1883. 8vo.

The authors, whose names are set out on the title-page of this book, have severally undertaken the different departments which go to make up the subject of the home. Dr. Richardson contributes an introduction on health. Then follow 28 chapters on architecture, dealing fully with site and aspect, internal construction, and external appearance of the house. Mr. Edis deals with internal decoration, Mr. Carter with lighting, Captain Galton with warming and ventilation, and Mr. Eassie, with house drainage. Dr. Corfield contributes two chapters on defective sanitary appliances and arrangements. And the editor three on the disposal of refuse by dry methods. Water, in its relation to health and disease, and the various questions that arise out of the subject, are discussed by Prof. de Chaumont, Mr. Rogers Field, and Mr. Wallace Peggs. The nursery is treated of by Dr. Squire; and then follows a chapter on house cleaning. The editor devotes three chapters to sickness in the home, and Mr. Gibbs concludes the work with an account of legal liabilities. The volume is very fully illustrated.

A CRITICAL ESSAY ON THE LIFE AND WORKS OF GEORGE TINWORTH. By Edmund W. Gosse, with a descriptive catalogue annexed. Illustrated

by 30 plates. London: published by the Fine Art Society, 1883. Oblong.

This is an *edition de luxe* of the essay which Mr. Gosse produced as a guide to the lately-closed exhibition of Tinworth's works, arranged by Messrs. Doulton at the Conduit-street gallery. To it have been added a series of photogravures, taken from the original terra cotta sculptures by Messrs. Goupil and Co. The models exhibited showed the work of about twenty years. On 22nd of December, 1864, Tinworth was admitted to the schools of the Royal Academy, and the first work exhibited in Tinworth gallery was designed in that year. The last, which represented the meeting of Jacob and Joseph, was produced in the present year. All the more important works are shown in the illustrations, besides many of a smaller size. The work has been printed by Messrs. Blades, East, and Blades.

General Notes.

TELEPHONE IN GERMANY.—the latest official report of the Imperial German Post-office states that at the end of October the telephone was fully in operation in the following cities and towns, within the Imperial postal territory (which does not include Bavaria or Würtemberg) :—Aix-la-Chapelle, Altona, Barmen, Berlin, Beuthen, Brunswick, Bremen, Bremerhaven, Breslan, Burstcheld, Charlottenburg, Chemnitz, Cologne, Crefeld, Deutz, Dresden, Düsseldorf, Elberfeld, Frankfort-on-Main, Hamburg, Hanover, Harburg, Kiel, Königsberg, Leipsic, Magdeburg, Mayence, Mannheim, Mülhausen (in Alsace), Potsdam, Stettin, Strassburg, and Wandsbek. In four other towns—Halle, Karlsruhe, M. Gladbach, and and Rheydt—the arrangements for its introduction have progressed so far that it will most probably be in operation in them before the end of this year. It is therefore likely that by the end of 1883, 40 towns within the Imperial German postal territory will possess the advantage of the telephone, against 21 last year, and seven in October, 1881.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 19...British Architects, 9, Conduit-street, W., 8 p.m. Mr. E. C. Robins, "The Fittings of Buildings for Applied Science and Art Instruction."

Asiatic, 22, Albemarle-street, W., 4 p.m. Mr. Habib Anthony Salmone, "The Importance to Great Britain of the Study of Arabic."

TUESDAY, Nov. 20...Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. W. Hackney, "The Adoption of Standard Forms of Test-pieces for Bars and Plates."

Statistical, Royal School of Mines, Jermyn-street, S.W., 7¾ p.m. Inaugural Address by the President, Dr. Robert Giffen.

Zoological, 11, Hanover-street, W., 8½ p.m. The Secretary, Report on recent additions to the Society's Menagerie. 1. Prof. Flower, "The Characters and Divisions of the Family Delphinidæ, or Dolphins." 2. Dr. Morrison Watson, "Additional Observations on the Structure of the Female Organs of the Indian Elephant." 3. Mr. F. Moore, "Descriptions of new Asiatic Diurnal Lepidoptera."

WEDNESDAY, Nov. 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p,m. Opening Meeting of the Session. Presentation of Medals.

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Edward Mawley, "Report on Temperatures in Different Patterns of Stevenson Screens." 2. Mr. Charles Harding, "The Storm which Crossed the British Islands between September 1st and 3rd, 1883, and its Track over the North Atlantic." 3. Mr. Robert Lawson, "The Influence of the Moon on the Height of the Barometer within the Tropics." 4. Mr. John Cordeaux, "The Ice Storm of July 3rd, 1883, in North Lincolnshire."

Geological, Burlington-house, W. 1. Professor R. Owen, "The Skull and Dentition of a Triassic Mammal, *Tritylodon longævus*, Owen, from South Africa." 2. Prof. R. Owen, "Cranial and Vertebral Characters of the Crocodilian genus, *Plesiosuchus*, Owen." 3. Prof. T. McKenny Hughes, "Some Tracks of Terrestrial and Freshwater Animals."

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Wm. Copeland Borlase, "Recent Discovery of Prehistoric Flint Implements in North America." 2. Rev. Prebendary Scarth, "Inscriptions Found in Hungary, and Trojan's Works on the Danube." Mr. Thomas Morgan, "Review of the Recent Congress at Dover."

THURSDAY, Nov. 22...Telegraph Engineers and Electricians, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Messrs. S. Trott and F. A. Hamilton, "Submarine Telegraph Cables, their Decay and Renewal." 2. Mr. H. Wingsford, "Trott and Kingsford's Automatic Grapnel for Submarine Cables and Torpedo Lines."

Parkes Museum, 44A, Margaret-street, W., 8 p.m. Mr. George Murray, "The Potato Disease."

FRIDAY, Nov. 23...Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, Nov. 24....Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. J. W. Clark, "On the Purification of Mercury by Distillation in Vacuo." 2. Professor R. B. Clifton, on "The Measurement of the Curvature of Lenses."

CONTRIBUTIONS TO THE READING-ROOM.

The Council beg leave to acknowledge, with thanks to the Proprietors, the regular receipt of the following Transactions of Societies and Periodicals during the year:—

TRANSACTIONS, &c.

Aeronautical Society, Annual Report.
Amateur Mechanical Society, Journal.
American Chemical Society, Journal.
American Philosophical Society, Transactions.
American Society of Civil Engineers, Transactions.
Art Union of London, Report.
Bath and West of England Society, Journal.
Bayerische Dampfkessel-Revisions-Verein, Bayerisches Industrie-und-Gewerbeblatt.
British Association for the Advancement of Science, Report.
British Horological Institute, Journal.
Chemical Society, Journal.
Chemico-Agricultural Society of Ulster, Journal.
Colonial Institute, Proceedings.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institute, Journal.
Gas Institute, Transactions.
Geological Society, Journal.
Geologists' Association, Proceedings.
Glasgow Philosophical Society, Proceedings.
Index Society, Publications.
India, Geological Survey of, Memoirs, Records, and Palæontologia Indica.
Indian Meteorological Memoirs.
Institute of Bankers, Journal.
Institution of Civil Engineers, Minutes of Proceedings.
Institution of Civil Engineers of Ireland, Transactions.
Institution of Engineers and Shipbuilders in Scotland, Transactions.
Institution of Mechanical Engineers, Proceedings.
Institution of Naval Architects, Transactions.
Iron and Steel Institute, Journal.
Linnæan Society, Journal.
Liverpool Literary and Philosophical Society, Proceedings.
Manchester Literary and Philosophical Society, Memoirs.
Manchester Steam Users' Association, Monthly Report.
Meteorological Society, Quarterly Journal.
Musée de l'Industrie de Belgique, Bulletin.
Musical Association, Proceedings.
National Association for the Promotion of Social Science, Sessional Proceedings.
National Indian Association, Journal.
National Life Boat Institution, Journal.
Pharmaceutical Society, Journal and Transactions.
Philadelphia Engineers, Club of, Proceedings.
Photographic Society of Great Britain, Journal.
Physical Society of London, Proceedings.
Quekett Microscopical Club, Journal.
Royal Agricultural Society, Journal.
Royal Asiatic Society, Journal.
Royal Astronomical Society, Memoirs.
Royal Colonial Institute, Proceedings.
Royal Cornwall Polytechnic Society, Report.
Royal Institution, Proceedings.
Royal Geographical Society, Proceedings and Journal.
Royal Irish Academy, Transactions and Proceedings.
Royal Scottish Society of Arts, Transactions.
Royal Society, Proceedings and Philosophical Transactions.
Royal United Service Institution, Journal.
Schlesische Gesellschaft für vaterländische Cultur, Jahres Bericht.
Société d'Encouragement pour l'Industrie Nationale, Bulletin.
Société Nationale d'Acclimatation de France, Bulletin Mensuel
Society of Antiquaries, Archæologia and Proceedings.
Society of Biblical Archæology, Transactions.
Society of Engineers, Transactions.
Society of Telegraph Engineers, Journal.
Statistical Society, Journal.
Victoria Institute, Journal.
Württemburg, Königliche Centralstelle für Gewerbe und Handel, Jahresberichte.
Zoological Society, Proceedings and Transactions.

PERIODICALS.

Twice a Week.

Commissioners' of Patents Journal.

Weekly.

Agricultural Gazette.
American Architect and Building News.
American Gas Light Journal.
American Pottery and Glassware Reporter.
Architect.
Ashore or Afloat.
Athenæum.
Bradstreet's.
British Architect and Northern Engineer
British Journal of Photography.
British Mercantile Gazette.
Builder.
Builders' Weekly Reporter.
Building and Engineering Times.
Building News.
Chemical News.
Chemiker-Zeitung.
Chronique Industrielle.
Colliery Guardian.
Colonies and India.
Cosmos ; Les Mondes.
Cultura, La
Draper.

Electrician.
Electricité, L'.
Empire.
Engineer.
Engineering.
English Mechanic.
European Mail.
Farmer and the Chamber of Agriculture Journal.
Furniture Gazette.
Gardeners' Chronicle.
Herapath's Railway Journal.
Inventors' Record and Industrial Guardian.
Irish Builder.
Iron.
Ironmonger.
Journal of Gas Lighting.
Journal d'Hygiène.
Land and Water.
London Iron Trade Exchange.
Mechanical World.
Medical Press and Circular.
Metropolitan.
Miller.
Millers' Gazette.
Mining Journal.
Moniteur Industriel.
Musical Standard.
Musical World.
Nature.
Oracle.
Photographic News.
Produce Markets' Review.
Queen.
School Board Chronicle.
Schoolmaster.
Scientific American.
Society.
Statist.
Temperance Record.
United States Patent Office, Official Gazette.
Warehousemen and Drapers' Trade Journal.

Fortnightly.

Art Interchange
Brewers' Guardian.
British and Colonial Printer and Stationer.
Finance Chronicle and Insurance Circular.
Gaceta Industrial.
Monde de la Science et de l'Industrie.
Moniteur des Produits Chimiques
Publishers' Circular.
Review of Gas and Water Engineering.
Steamship.

Monthly.

American Journal of Science.
Analyst.
Antiquary.
Artist.
Bibliographer.
Bookseller.
British Colonial World.
British Mail.
British Trade Journal.
Building Societies' Gazette.
Building World.
Cabinet Maker.
Canadian Patent Office Record.
Caterer, Hotel Proprietor and Refreshment Contractor's Gazette.
Chemist and Druggist.
Decorator and Furnisher.
Dyer.
Educational Times.
Electrical Engineer.
Foreman Engineer and Draughtsman.
Gas Engineer.
Journal of Education.
Journal of Science.
Journal Telegraphique.
Leather Trades' Circular.
Machinery Market.
Magazine of Art.
Manufacturers' Review and Industrial Record.
Marine Engineer.
Mineral Water Trade Review and Guardian.
Moniteur Scientifique.
Nautical Magazine.
Orchestra and the Choir.
Paper Makers' Circular.
Paper Makers' Monthly Journal.
Photographic Times and American Photographer.
Pottery Gazette.
Planters' Gazette and Commercial News.
Revue Industrielle.
Revue Maritime et Coloniale.
Saddlers, Harness Makers, and Carriage Builders' Gazette.
Sanitary Record.
Stationer.
Sugar Cane.
Symons's Meteorological Magazine.
Telegraphic Journal and Electrical Review.
Textile Manufacturer.
Textile Recorder.
Watchmaker, Jeweller, and Silversmith.

Two-Monthly.

Coach Builders', Harness Makers', and Saddlers' Art Journal.

NEWSPAPERS.

Belgian News.
Bombay Gazette, Overland Summary.
Ceylon Observer & Weekly Summary of Intelligence.
Ceylon Times, Weekly Summary.
City
Eastern Post.
Home and Colonial Mail.
London and China Telegraph.
Nottinghamshire Guardian.
Sheffield and Rotherham Independent.
Staffordshire Sentinel.
Times of India (Overland Weekly Edition).
West London Observer.

INDEX TO VOL. XXXI.

A.

Abel, Sir Frederick, C.B., F.R.S., elected member of Council, 79; *chair*, self-purification of peaty rivers, 469; appointed judge for prize for miners' safety lamp, 419; *disc.*, new process for the separation and recovery of the volatile constituents of coal, 678; various agents employed to render materials uninflammable, 691; *disc.*, prevention of fires in theatres, 751

Adams, Prof. W. G., F.R.S., *disc.*, measurement of electricity, 508

Aeronautical exhibition, Paris, 711

Agriculture, institute of, 856

——— in Lower Bengal, *paper* by W. S. Seton-Karr, 419; in Bologna, 645; in Canada, 972; in Mozambique, 878; in Venezuela, 958

Agricultural congress at Paris, 95

——— lectures, 416

——— machinery, recent improvements in, *paper* by D. Pidgeon, 317

——— returns, 916

——— shows in France, 345

Ainslie, Mr., *disc.*, ensilage in the United States, 237

Air, compressed, engine for tram-cars, 684

Albert medal, list of awards, 379; award to Sir Joseph Hooker, K.C.S.I., F.R.S., 775; report of the council, 798

Alcock, Sir Rutherford, K.C.B., *chair*, overland route towards China from India *viâ* Assam, 305; *chair*, relative claims of etching and engraving to rank as fine arts, 713

Algin from seaweed, 808

Alment, E. J., presentation of prize to, for plant label, 14

America (see "United States")

Amsterdam exhibition, 33

———-, international congress at, 959

Anderton canal lift, *letter* by Sidingham Duer, 376

Andrew, Captain Charles, presentation of medal to, for the sanitary arrangements of his house, 14

Angers hemp industry, 843

Anthracite coal-fields of Pennsylvania, 28

Antiseptic action of spongy iron, *letter* by G. Bischof, 444; *letter* by Jabez Hogg, 467

Archæological (British) institute, 820

Archer, Mr., *disc.*, Queensland, its progress and resources, 766

Architectural exhibition, Brussels, 729

Architecture, domestic, of India, *paper* by C. Purdon Clarke, 731

Argentine republic, eucalyptus tree in the, 831

Armour, H. L., *disc.*, new process for the separation and recovery of the volatile constituents of coal, 678

Armstrong, Prof. H. E., F.R.S., *chair*, technical aspects of lignification, 220

Art industries in British Burma, 412

Arts (graphic), exhibition of, at Vienna, 685

Asbestos in Italy, 445

Asia, Russian trade with, 772

Asphalte deposits in Mexico, 818

Assam, overland route towards China from India, *viâ*, *paper* by C. H. Lepper, 305; *letter*, 343

Astrop, Mr., *disc.*, prevention of fires in theatres, 747

Atkinson, R. W., *paper*, the formation of diastase from grain by moulds, 545

Aumonier, F., *disc.*, ice-making and refrigerating, 253; *disc.*, increasing destruction of life and property by fire, 773

Australasia, growth of, 818

Australia, gold in, 445

Austria, metal industry, 95

———, beer exhibition at Saaz, 175

Ayrton, Prof., F.R.S., *disc.*, transmission of power by electricity, 539

B.

Bagnall, Mr., *disc.*, development of Irish industries, 437

Bahamas, sponge trade of the, 410

Baku, petroleum supply of, 818

Balmokand, Mr., *disc.*, domestic architecture of India, 741

Barcroft, H., *letter*, Portrush electric railway, 573

Barff, Prof., presentation of medal to, 13

Bark as a paper-making material, 93

Barker, Mr., *disc.*, Government patent bill, 568

Barry, J. G., *letter*, prevention of fires, 415

Bartlett, Dr., *disc.*, sanitary inspection of houses, 186

Bateman-Champain, Col., R.E., *chair*, life among the Turcoman Nomads, 246; *paper*, the trade routes of Persia 487; Society's silver medal awarded to, 757

Batteries, secondary, *Cantor lectures* by Prof. Oliver Lodge, 1025, 1038; syllabus, 544

Bee-keeping in India, 982

Beer, Austrian, exhibition, 175

——-, sour, *letter*, 1051

Belgium, mineral wealth of, 511; parcels post in, 115; woollen industry of, 175

Bengal, cinchona cultivation in, 969

——— (Lower), agriculture in, *paper* by W. S. Seton-Karr, 419

Berlin, proposed exhibition at, 18; Brazilian exhibition at, 27; hygiene and life-saving exhibition, 1883, 723

Bicker-Caarten, Chevalier, *disc.*, utilisation of waste, 614

Birch, George H., *Cantor lectures*, the decorative treatment of metal in architecture, 905, 917, 937; syllabus, 446

Birdwood, Sir George, M.D., *chair*, domestic architecture of India, 731; native press of India, 1007

Bischof, Dr. G., *letter*, antiseptic action of spongy iron, 444

Black Forest, ceramics in, 710

Blakesley, T. H., *disc.*, measurement of electricity, 505; *letter*, 543; *disc.*, electricity as a motive power, 543

Blashfield, J. M., *obituary*, 136

Blast furnaces, 416

Bloomfield, J. C., *disc.*, artificial drying of crops, 737; *paper*, the development of Irish industries, 432; *disc.*, transmission of power by electricity, 540

Bolas, T., *disc.*, Government patent bill, 568

Bologna, agriculture in, 645; exhibition of hemp-preparing machine at, 711

Bombyces, silk producing, reared in 1882 by Alfred Watts, 189, 214, 239, 340

Bonifacio, Mr. *disc.*, Queensland, its progress and resources, 767

Books, Notes on:—

Banner, E. G., wholesome houses, 183

Beckett, Sir Edmund, rudimentary treatise on clocks, watches, and bells, 773

Buchan, W. P., plumbing, 773
Caine, T. Hall, recollections of Dante G. Rossetti, 217
Carpenter, W. Lant, energy in nature, 1051
Christmas cards, 1024
Christy, T., ensilage, 415
Clark, Latimer, transit tables for 1883, 345
Denton, Bailey, handbook of house sanitation, 193
Dredge, J., electric illumination, 174
Dresser, Dr., Japan, 51
Du Moncel, Count, electricity as a motive power, 1023
Eastlake, C. L., notes on the Louvre gallery, 773
———, notes on the Brera gallery, 773
Faber, G. L., fisheries in the Adriatic, 819
Fisheries exhibition, papers of the conferences and handbooks, 844, 983
Forsyth, D., instruction in linear perspective, 984
Gibb, E. J. W., Ottoman poems, 648
Gosse, E. W., essay on the life and works of George Tinworth, 1051
Ingram, J. H., Oliver Madox Brown, 984
Maclochlin, J., education, 773
Morris, D., Cacao, 217
Murphy, S. H., our homes, 1051
Peek, F., social wreckage, 217
Philipson, J., harness, 415
Rawlinson, Sir Robert, hygiene of armies in the field, 984
Ridsdale, A. H., chemical per-centage tables, 345
Rogers, J. E. Thorold, ensilage in America, 415
Siemens, Sir William, on the conservation of solar energy, 648
Smoke abatement committee report, 344
Tarbuck, E. L., handbook of home property, 819
Tolhausen, A., dictionnaire technologique, 648
Vincent, F., land of the white elephant, 51
Boord, T. W., M.P., *chair*, the modern lathe, 255
Boracic lagoons in Italy, 416
Boston exhibition, 605
Botany, economic, at Kew, 569, 603
Botly, Wm., *disc.*, ice-making and refrigerating, 25; *disc.*, sanitary inspection of houses, 187; *disc.*, agricultural machinery, 338; *disc.*, development of Irish industries, 439; *disc.*, economy in sanitation, 590
Boult, A. J., *disc.*, Government patent bill, 593
Boyle, Mr., *disc.*, the modern lathe, 267
Boys, C. V., *disc.*, measurement of electricity, 509
Bramwell, Sir Frederick, F.R.S., vote of thanks for chairman's address, 14; *chair*, collisions at sea, 35; adjourned meeting, 53; *letter*, Jacob Perkins's ice-making machine, 76; *chair*, agricultural machinery, 317; *disc.*, Government patent bill, 594; *paper*, Society of Arts patent bill, and some points in American patent law, and practice bearing thereon, 285; thanks voted by council for his *paper*, 757
Brazilian exhibition at Berlin, 27
British Association, arrangements for meeting at Southport, 667; report of the screw-gauge committee, 115; report on the underground waters, 1000; abstracts of papers, 980, 961
Bromine in the United States, 1047
Browne, H. C. Gore, *disc.*, development of electric lighting, 789
Browne, Walter, *disc.*, the Society of Arts patent bill, 298; *disc.*, new process for the separation and recovery of the volatile constituents of coal, 679
Browning, Dr., *disc.*, economy in sanitation, 592
Brussels architectural exhibition, 729
———, commercial museum of, 117
———, lace and fan exhibition at, 51
——— photographic exhibition, 217
Bryan, W. B., *letter*, iron drain pipes with lead joints, 268
Buchan, W. P., *letter*, sanitary inspection of houses, 242; *letter*, iron drain pipes with lead joints, 268
Building exhibition, 663
Burma, art industries in, 412
Burton, Capt. Richard F., presentation of medal to, 13
Burton, W. K., *paper*, the sanitary inspection of houses, 178

C.

Cables, submarine, conference for the protection of, 94
Cadiz, salt industry of, 182
Caen industrial exhibition, 820
Cagliari exhibition of purifying apparatus, 667, 810, 844, 948
Caird, Sir James, K.C.B., *chair*, settlement systems of India, 517
Calabria and Sicily, submarine communication between, 269
Calculating machine, new one by H. Beaucourt, 28
Calcutta exhibition, 157, 415, 649, 756, 1048
California, vineyards of, 34
Campbell, Charles, *disc.*, agriculture in Lower Bengal, 429
Campin, F. W., *obituary*, 514
Canada, agriculture in, 972
Canal lift, Anderton, *letter* by Sidingham Duer, 376
Candlemaking (see "Illuminating Agents")
CANTOR LECTURES:—
1st Course:—"Dynamo-electric machinery," by Prof. Silvanus P. Thompson, D.Sc., 119, 137, 159; syllabus, 2
2nd Course:—"Solid and liquid illuminating agents," by Leopold Field, 821, 833, 846, 857, 869, 881; syllabus, 218
3rd Course:—"The decorative treatment of metal in architecture," by George H. Birch, 905, 917, 937; syllabus, 446
4th Course:—"The transmission of energy," by Prof. Osborne Reynolds, M.A., F.R.S., 973, 985, 995; syllabus, 544
5th Course:—"Secondary batteries and the electrical storage of energy," by Prof. Oliver J. Lodge, M.A., D.Sc., 1025, 1038; syllabus, 686
Report of the Council, 797
Caracas, international exhibition of, 415
Carpenter, W. Lant, *letter*, New Zealand, 465; *disc.*, development of electric lighting, 789
Carpmael, Alfred, *disc.*, the Society of Arts' patent bill, 297; *disc.*, Government patent bill, 600
Carpmael, William, *disc.*, Government patent bill, 594
Cassels, Andrew, *disc.*, overland route towards China, 315; *disc.*, agriculture in Lower Bengal, 430; *chair*, fisheries of India, 609
Cassia lignea in China, 512
Cement, adulteration of, 245
Ceramic and glass exhibition, Paris, 992
Ceramics in the Black Forest, 710
Ceylon botanic garden, economic plants in the, 828; silkworm culture in, 856
Chadwick, E., C.B., *letter*, school children of the metropolis, 29; *letter*, sanitary inspection of houses, 188; *letter*, economy in sanitation, 592; on cholera epidemics, 844
Challen, Mr., *disc.*, history of the pianoforte, 408
Chamærops humilis (dwarf palm), 892, 1034, 1047
Champagne making in France, 408
Chance, A. M., presentation of medal to, 13
Channel tunnel, 948
CHEMISTRY AND PHYSICS, SECTION OF APPLIED:—
1st Meeting:—"Technical aspects of lignification," by F. Cross, 220
2nd Meeting:—"Some causes of fires, and methods for their prevention," by Walter G. McMillan, 380
3rd Meeting:—"Self-purification of peaty rivers," by W. N. Hartley, 469
4th Meeting:—"The formation of diastase from grain by moulds," by R. W. Atkinson, 545
5th Meeting:—"A new process for the recovery of the volatile constituents of coal," by T. B. Lightfoot, 669
6th Meeting:—"The development of electric lighting," by J. E. H. Gordon, 778
Report of the council, 797
Chicory as a vegetable, 683
——— trade in Germany, 606
China, cassia lignea in, 512; electric light in, 158; English goods and Chinese buyers, by Hon. H. N. Shore, 813; fish

culture in, 1001; overland route towards, from India *viâ* Assam, *paper* by C. H. Lepper, 305; *letter*, 343
China grass, cultivation of, 342; *letter* by C. E. Collyer, 376, 1031
Chinese tea trade, 856
Cholera epidemics, 844
Churchill, Lord Alfred S., vote of thanks to chairman, 14; *disc.*, transmission of power by electricity, 641; *disc.*, prevention of fires in theatres, 753; seconds the adoption of report, 805; vote of thanks to the chairman, 806; *letter* on inquests on fires, 904
Cinchona cultivation in Bengal, 969
——— ledgeriana, 729
Clarke, C. Purdon, *paper*, some notes on the domestic architecture of India, 731
Clarke, Hyde, *chair*, utilisation of waste, 97; *chair*, Egypt present and to come, 347; *disc.*, trade routes of Persia, 495
Clements, H., *disc.*, ice-making and refrigerating, 25; *disc.*, artificial drying of crops, 73; *letter*, utilisation of waste, 135
Clifford, Sir Charles, *chair*, social and commercial aspects of New Zealand, 447
Coal, a new process for the separation and recovery of the volatile constituents of, *paper* by T. B. Lightfoot, 669
—— production of the world, 34, 975
—— in New South Wales, 1024
Coal and iron industries of Russia, 934
Coal-fields of New Zealand, 342; (anthracite) of Pennsylvania, 28
Coal-mines in Yorkshire, 975
Cobb, B. Francis, *disc.*, collisions at sea, 47; *disc.*, Suez canal, 212; annual meeting, 806
Cochin China, minerals in, 415
Cocoanut fibre, 771
Cola, P. R., *letter* on railways in India, 606
Coleman, J. J., *disc.*, ice-making and refrigerating, 24
Coles, W. R. E., *disc.*, new process for the separation and recovery of the volatile constituents of coal, 678
Collins, H. H., *disc.*, sanitary inspection of houses, 187; *disc.*, economy in sanitation, 592
Collins, James, dwarf palm as a paper material, 1034
Collisions at sea, *paper*, Captain P. H. Colomb, 36; adjourned discussion, 53; appointment of a committee to consider the question of preventing, 447; report of the council, 799
Collyer, C. E., *letter*, cultivation of China grass, 376
Colomb, Captain P. H., R.N., *paper*, collisions at sea, 36; adjourned discussion, 53
Comet, spectroscopic observations of the, *letter* by C. Sohn, 18
Commercial museum of Brussels, 117
Committees:—
Collisions at sea, 447
Foreign and Colonial section, 53
Indian section, 35
Prevention of fires, report, 687
Conversazione of the Society, 845; report of the council, 802
Coode, Sir John, *disc.*, Suez canal, 213
Cooper, Sir Daniel, Bart., K.C.M.G., presentation of medal to, for sanitary arrangements of his house, 14
Corbaux, Fanny, *obituary*, 303
Corfield, Prof., *disc.*, self-purification of peaty rivers, 482
ork, production of, 647
Cork exhibition, 269, 415
Cott, Mr., *disc.*, ice-making and refrigerating, 24
Cotton, Mr., *disc.*, historical development of the different settlement systems of India, 529
Cotton industry in Italy, 157; in Switzerland, 1004; in the United States, 444
——— seed oil, 867
——— yarn, tests for, 726; in France, 1006
Council:—
Sir Frederick Abel, elected member in place of Lord Otho Fitzgerald, 79; annual report, 794; new council, 803; elected, 806; Sir Wm. Siemens elected chairman, 821; new members, 833
Coussmaker, Major G., report on Tasar silk, 769
Crefeld, manufacture of silk at, 1046
Cresswell, C. N., *disc.*, sanitary inspection of houses, 187; *letter*, 242; *disc.*, economy in sanitation, 590; *letter*, Wrexham sewage, 1050
Cripps, Wilfred, *paper*, English and foreign silver work, with some remarks on hall-marking, 652
Crops, artificial drying of, *paper* by W. A. Gibbs, 61
Cross, C. F., *paper*, technical aspects of lignification, 991; *letter*, 302
Crosskill, *disc.*, agricultural machinery, 137
Cunliffe-Owen, Sir Philip, K.C.M.G., C.B., annual meeting, 806; seconds vote of thanks to chairman, 806
Cunningham, Mr., *disc.*, transmission of power by electricity, 541
Currey, Mr., *disc.*, electrical exhibitions, 85
Currie, Sir Donald, K.C.M.G., M.P., *chair*, social conditions and prospects of Madagascar, 271
Curtain, iron, for theatres, 269
Cust, R. N., *disc.*, agriculture in Lower Bengal, 429

D.

Dangerous and unhealthy industries of France, 93
Danvers, Juland, *disc.*, domestic architecture of India, 741
Darby, S., *disc.*, ensilage in the United States, 238
Day, Surgeon-General Francis, *paper*, fisheries of India, 505
De Chaumont, Prof., F.R.S., *disc.*, economy in sanitation, 591
De Rance, C. E., *disc.*, self-purification of peaty rivers, 483
Deacon, G. F., presentation of medal to, 13
Denham, W. H., *letter*, sanitary inspection of houses, 302
Dennis, Mr., *disc.*, prevention of fires in theatres, 753
Denton, E. P. Bailey, *disc.*, sanitary inspection of houses, 186
Denver mining exhibition, 607
Diastase, formation of, from grain, by the action of moulds, *paper* by R. W. Atkinson, 545
Dilke, Ashton Wentworth, *obituary*, 445
Dipnall, M. S. S., *disc.*, collisions at sea, 49
Dixon, E. M., *disc.*, technical instruction in elementary and intermediate schools, 708
Dixon-Hartland, F. D., M.P., *disc.*, prevention of fires in theatres, 749
Donovan, Mr., *disc.*, increasing destruction of life and property by fire, 373
Dowson, J. E., presentation of medal to, 13
Drain-pipes (iron) with lead joints, *letters*, B. H. Thwaite, 242; W. P. Buchan, 208; W. B. Bryan, C.B., 208, 209
Drill, School Board, 810
Druce, S. B. L., *disc.*, artificial drying of crops, 72; *disc.*, ensilage in the United States, 238
Drying, artificial, of crops, *paper* by Wm. A. Gibbs, 61
Duer, Sidingham, *letter*, Anderton canal lift, 376
Duncan, J., *disc.*, artificial drying of crops, 72; ensilage in the United States, 236
Dutt, Krishnalal, *disc.*, agriculture in Lower Bengal, 429
Dynamo, Elphinstone and Vincent, 416
Dynamo-electric machinery, *Cantor lectures*, by Professor Silvanus Thompson, 119, 137, 159; syllabus, 2

E

Eavestaff, W. G., *disc.*, history of the pianoforte, 468
Eden, Sir Ashley, K.C.S.I., *chair*, agriculture in Lower Bengal, 419
Edmunds, Dr., *disc.*, the modern lathe, 265
Education:—
School children of the metropolis, *letter* by E. Chadwick, C.B., 29
Technical instruction in elementary and intermediate schools, *paper* by P. Magnus, 695
Egypt, present and to come, *paper* by R. W. Felkin, 347; *letter* by General Rundall, 413; railway route in, *letter* by R. W. Felkin, 514

Egypt, (see "Suez Canal")
Electric head-light for locomotives, 94
——— launch, 866
——— light in China, 158; at Middlesbrough, 1003; in New York, 515
——— lighting, development of, *paper* by J. E. H. Gordon, 778; fire risks of, 963
——— railway, Portrush, *letter* by H. Barcroft, 573
——— safety lamps, prize offered for, 193
——— telegraphs, report of the council, 802; in Europe, 832
Electrical accumulators, 1047
——— (see "Secondary batteries")
——— competition in France, 376
——— exhibition at Prague, 193; at Philadelphia, 1884, 984; at Vienna, 78, 345, 607, 685
——— exhibitions, *paper* by W. H. Preece, 80
——— safety appliances for theatres, 515
Electricity, measurement of, *paper* by J. N. Shoolbred, 497; *letter* by T. H. Blakesley, 543; transmission of power by, 136; *paper* by Alexander Siemens and E. Hopkinson, 531; as a motive power, *paper* by Professor Geo. Forbes, 631
———, see "Secondary batteries."
Electro-plate, bounty on, *letter* by W. M. Wood, 685
Elphinstone and Vincent dynamo machine, 416
Embroidery industry at Nancy, 1047
Energy, transmission of, *Cantor lectures* by Prof. Osborne Reynolds, F.R.S., 973, 985, 995; syllabus, 544
———, electrical storage of, *Cantor lectures* by Professor Oliver Lodge, 1025, 1038
Engineers, Institution of Civil, list of lectures, 1047
Engines, compound locomotive, by F. W. Webb, 980
Engraving and etching, their relative claims to rank as fine arts, *paper* by F. Seymour Haden, 714
Ensilage in the United States, *paper* by Prof. J. C. Thorold Rogers, M.P., 229; experiments on, 810, 868, 960; Prof. Thorold Rogers on, 1023
Epping Forest, proposed railway to, 345
Etching and engraving, their relative claims to rank as fine arts, *paper* by F. Seymour Haden, 714
Eucalyptus tree in the Argentine Republic, 831
Euphrates-valley railway as an alternative route to India, 961
Evans, J. H., *paper*, the modern lathe, 256
EXAMINATIONS, RESULTS FOR 1883, 713; report of council, 801
Vocal and instrumental music, 651; report of the council, 802
Technological, at City and Guilds Institute, 864; 1884, 869
Exhibitions, relations of the State to, 411
———, forthcoming, 1024
EXHIBITIONS:—
Amsterdam, 33
———, international congress in connection with the exhibition, 723
Austro-Hungarian, 916
Berlin, one proposed at, 18
———, hygiene and life-saving, 723
———, Brazilian at, 27
Bologna, hemp-preparing machines, 711
Boston, 605
Brussels, architectural, 729
———, lace and fan, 51
———, photographic, 217
Caen industrial, 820
Cagliari, pumping apparatus, 667, 810, 844, 948
Calcutta, 157, 415, 649, 756, 1048
Caracas, 415
Cork, 269, 415
Denver mining, 607
Edinburgh forestry, 1884, 992
Ghent, industrial art, 134, 712, 756
London fisheries, opening, 663; *papers* on, 896, 930, 950, 965; Russian section, 770; conferences, 756, 772; closed, 1030
———, proposed international, 1030
London, building, at Agricultural-hall, 663
———, furniture, at Agricultural-hall, 683
———, meteorological instruments, 303
Louisville, southern exposition, 667
Madrid mining, 756
Marseilles, 981
———, maritime, 1036
Munich art, 136, 468, 820
Nice, 774, 975
Paris, ceramic and glass, 992
——, international railway safety, 118
——, aeronautical, 711
Philadelphia electrical, 984
Prague electrical and industrial, 193
Saaz, Austrian beer, 175
St. Petersburg horticultural, 415, 607
Turin, 711
Vienna electrical, 78, 345, 607, 685
——— graphic arts, 685
Zurich national, 729, 890
Explosive, new, 668

F.

Fahie, J. J., *letter*, trade routes of Persia, 571
Fan and lace exhibition at Brussels, 51
Fayrer, Sir Joseph, *disc.*, fisheries of India, 629
Felkin, Robert W., *paper*, Egypt, present and to come, 347; *letter*, Egypt, 514
Fibre plants of India by J. W. Minchin, 893; of Mexico, 1035
Field, Leopold, *Cantor lectures*, solid and liquid illuminating agents, 821, 833, 846, 857, 869, 881; syllabus, 218
Field, Rogers, *disc.*, sanitary inspection of houses, 186; *letter*, 216
Fildes, Mr., *disc.*, ice-making and refrigerating, 25
Finance, report of the council, 804
Financial statement, 776
Fire, on the increasing destruction of life and property by, *paper*, by Cornelius Walford, 363
—— extinction, injector hydrant for, by J. H. Greathead, 963
—— risks of electric lighting, 963
—— brigade in Rome, 1045
Fires, some causes of, and methods for their prevention, *paper* by W. G. Macmillan, 380; prevention of, *letter* by J. G. Barry, 415; report of committee, 687; inquests on, *letter* by Lord Alfred S. Churchill, 904; in forests, 241
—— in theatres, prevention of, meeting to consider report on, 746; resolutions passed, 753; *letter*, H. Mitchell, 773; report of the council, 799; letter to the Secretary of State for the Home Department, 811
Fish analyses, 957
—— culture in China, 1001
—— monopoly, Society of Arts' attempt to break it down, 1761, 979
Fisheries of France in 1881, 817; of India, *paper* by Francis Day, 609; of Japan, 90; of Russia, 865
——— exhibition, opening, 663; papers on, 896, 930, 950, 965; conferences, 756, 772; Russian section, 770; closed, 1030
Fishing trade of Great Grimsby, 17
Fitzgerald, Lord Otho, *obituary*, 33
Flax, cultivation of, in the United States, 412
Flaxman and the Society of Arts, 416
Fletcher, T., *letter* on dwarf palm, 1047
Foods, tinned, 1046
Forbes, Prof. George, *paper*, electricity as a motive power, 631
FOREIGN AND COLONIAL SECTION:—
Meeting of committee, 53
1st Meeting:—"Life among the Turcoman Nomads," by Edmond O'Donovan, 246
2nd Meeting:—"Social conditions and prospects of Madagascar," by Rev. J. Peill, 271

3rd Meeting :—"Egypt, present and to come," by Robert W. Felkin, 347
4th Meeting :—"Social and commercial aspects of New Zealand," by W. Delisle Hay, 447
5th Meeting :—"The trade routes of Persia," by Colonel Bateman-Champain, R.E., 487
6th Meeting :—"Queensland: its progress and resources," by Arthur J. Stanesby, 758
Report of the council, 796
Forest culture in Germany, 681
—— fires, 241
Forestry in Europe and America, 956; education in, report of the council, 800; debate in the House of Commons, 877; international exhibition, 1884, 992
Fortnum, C. D. E., *disc.*, relative claims of etching and engraving to rank as fine arts, 722
Forwood, Mr., *disc.*, collisions at sea, 57
Fox, F. W., *disc.*, Suez Canal, 212
France, champagne making in, 408; cotton yarn in, 1006; dangerous and unhealthy industries of, 93; electrical competition in, 376; population of, 729; vine disease in, 727
Frankland, Dr. Percy, *disc.*, self-purification of peaty rivers, 483
French academy competitions, and prizes, 514, 543; agricultural shows, 345; fisheries in 1881, 817; technical schools, 243; tobacco statistics, 820
Fruit trade, canned, of San Francisco, 960
Fry, George, *disc.*, technical aspects of lignification, 227; *disc.*, ensilage in the United States, 237
Furniture exhibition, 683

G.

Galton, Capt. Douglas, C.B., F.R.S., *chair*, sanitary inspection of houses, 177; *letter*, 242; *chair*, the Society of Arts' patent bill, 285; *paper*, economy in sanitation, 575; Society's silver medal awarded to, 757
Ganga Ram, Mr. *disc.*, domestic architecture of India, 740
Garrard, Mr., *disc.*, English and foreign silver work, 662
Gas-engine, early, 95
Gases, illuminative power of, 1048
German, chicory trade, 606
Germany forest culture in, 681
—— telephone in, 1052
Ghent, industrial art exhibition, 134, 712, 756
Gibbs, Sir B. T. Brandreth, *chair*, ensilage in the United States, 229
Gibbs, William A., *paper*, the artificial drying of crops, 61; *letter*, ensilage in the United States, 235
Gibson, E., *disc.*, ensilage in the United States, 237
Gilchrist, P. C., presentation of medal to, 13
Glass exhibition, Paris, 992
—— manufacture, improvements in, 820
Glover, John, *disc.*, collisions at sea, 49
Glycerine, silvering mirrors by means of, 515
Gold in Australasia, 445
—— production in the United States, 646
—— and silver, production of, in Mexico, 959
Goldsmiths' Company, constitution of the, 652; prizes, 303
Gordon, J. E. H., *paper*, the development of electric lighting, 778
Graham, Prof. C., *chair*, formation of diastase from grain, 545
Grain, formation of diastase from, by the action of moulds, *paper* by R. W. Atkinson, 545
Grape culture and wine making in Russia, 970
Greenwich observatory, report of Astronomer-Royal, 733
Grimsby (Great), fishing trade of, 17
Gumpel, C. G., *disc.*, electricity as a motive power, 642; *disc.*, development of electric lighting, 789

H.

Haden, F. Seymour, *paper*, the relative claims of etching and engraving to rank as fine arts, 714; Society's silver medal awarded to, 757
Hall-marking, compulsory, 652
Hammond, R., *disc.*, measurement of electricity, 808
Hampton, Mr., *disc.*, Government patent bill, 568
Harrowby, Earl of, *obituary*, 33
Hart, Ernest, *disc.*, ice-making and refrigerating, 24
Hartley, W. N., *paper*, self-purification of peaty rivers, 469
Harvesting, artificial drying of crops, *paper* by W. A. Gibbs, 61
Harvests earlier, and change of seeds, *letter*, Dr. John Yeats, 880
Haslam, A. S., *disc.*, ice-making and refrigerating, 25
Haughton, W., *disc.*, Government patent bill, 568
Hawkridge, Mr., *disc.*, prevention of fires in theatres, 747
Hawkshaw, Sir John, F.R.S., *chair*, Suez Canal, 195
Hay, W. Delisle, *paper*, social and commercial aspects of New Zealand, 447
Heathorn, Capt., *disc.*, collisions at sea, 49
Hebb, John, *disc.*, prevention of fires in theatres, 748
Hemp industry at Angus, 843
Hemp-preparing machines, exhibition of, at Bologna, 711
Henry, Mitchell, M.P., *chair*, development of Irish industries, 432
Herman, H., *disc.*, prevention of fires in theatres, 746
Higgins, Clement, *disc.*, Government patent bill, 567
Hill's, John, penny post, 989
Hine, Mr., *disc.*, prevention of fines in theatres, 747
Hipkins, A. J., *paper*, the history of the pianoforte, 757; Society's silver medal awarded to, 757; appendix to the paper, 949
Hogg, Jabez, *letter*, chemical analysis of drinking water, 414; *letter*, antiseptic action of spongy iron, 467
Homersham, S. C., *disc.*, self-purification of peaty rivers, 482
Hooker, Sir Joseph, K.C.S.I., F.R.S., award of Albert medal to, 775
Hopkinson, Edward, and Alexander Siemens, *papers* (1) the transmission of power by electricity; (2) the Portrush electrical railway, 531; Society's silver medal awarded to, 757
Hopkinson, Dr. J., F.R.S., *paper*, ice-making and refrigerating, 19; *disc.*, transmission of power by electricity, 541
Horticultural exhibition at St. Petersburg, 415, 607
Hospital administration, 810
House, renovation of the Society's, 5; report of council, 803
House sanitation competition, presentation of medals, 14
Hughes, Mr., *disc.*, ice-making and refrigerating, 25
Hungary, iron industry of, 981; population and education in, 902
Hutt, Sir William, K.C.B., *obituary*, 51
Hydrant, injector, for fire extinction, 963
Hydraulic machinery, *letter* by J. Perry, 302
Hygiene and life-saving exhibition, Berlin, 1882, 721

I.

Ibbotson, Alfred, *letter*, Government patent bill, 567
Ice-making and refrigerating, *paper*, Dr. J. Hopkinson, F.R.S., 19; Jacob Perkins's machine, *letter* by Sir Frederick Bramwell, 76
Illuminating agents, solid and liquid. *Cantor lectures* by Leopold Field, 821, 833, 846, 857, 869, 881; syllabus, 696
Illuminative power of gases, 1048
Imray, J. F., *disc.*, the Society of Arts' patent bill, 288
Indexes, patent-office, 134
India, bee-keeping in, 982; domestic architecture of, *paper* by C. Purdon Clark, 731; economic plants of, 393; fibre plants of, by J. W. Minchin, 803; fisheries of, *paper* by Francis Day, 609; historical development of the different settlement systems of, *paper* by W. G. Pedder, 617; native press of, 1007; railways in, *letter* by P. R. Cola, 1042; Euphrates railway as an alternative route to India, 1042; overland route towards China from, and Assam, *paper* by C. H. Lepper, 305; *letter*, 343
India-rubber, behaviour of, when subjected to tension, 74

INDIAN SECTION:—
Meeting of committee, 35; report of the council, 796
1st Meeting:—"Overland commercial communication between India and China, *viâ* Assam," by Charles H. Lepper, 305
2nd Meeting:—"Agriculture in Lower Bengal," by W. S. Seton-Karr, 419
3rd Meeting:—"Historical development of the different settlement systems of British India," by W. G. Pedder, 517
4th Meeting:—"Fisheries of India," by Surgeon-General Francis Day, 609
5th Meeting:—"Some notes on the domestic architecture of India," by C. Purdon Clarke, 731
Indian wheat, 807
Industrial art exhibition, Ghent 134, 712, 756
Inglefield, Admiral Sir E. A., elected member of council, 833
INSTITUTIONS IN UNION:—
Aberdeen, Robert Gordon's College, 177
————, Preparatory Institute, 995
Walsall Science and Art Institute, 995
Wilton Art Classes, Wilton, Salisbury, 5
Irish industries, development of, *paper* by J. C. Bloomfield, 432
Iron (spongy), antiseptic action of, *letter* by G. Bishop, 445; *letter* by Jabez Hogg, 467
Iron drain-pipes, with lead joints, *letters* by B. H. Thwaite, 242; W. P. Buchan, 268; W. B. Bryan, 268; C. B., 299
Iron industry, of Hungary, 981; of New South Wales, 1006; of Russia, 934
Iron ore fields of Lapland, 92
Italy, asbestos in, 445; boracic lagoons in, 416; industry, 157; railways, 1034

J.

Jamaica, economic plants in, 725
Jameson, J., *disc.*, new process for the separation and recovery of the volatile constituents of coal, 679
Japan, cultivation of rice in, 16; fisheries of, 90; seaweed of, 91
Jenkins, H. L., *letter*, trade route towards China, 313
Jolley, Mrs., *disc.*, ice-making and refrigerating, 25
Jones, Admiral Gore, *disc.*, social condition and prospects of Madagascar, 282
Jones (Owen) prizes for furniture designs, 245; report of the council, 801; awards 1883, 905
Juvenile lectures, "The inhabitants of the ocean," by Prof. H. N. Moseley, F.R.S., 137, 159; report of the council, 798

K.

Kew, economic botany at, 569, 603
Kimber, Edmond, *disc.*, overland route towards China, 316; *disc.*, historical development of the different settlement systems of India, 529; *disc.*, fisheries of India, 618
Kôji, diastase of, 545
Kola-nut tree, 50
Krishnalal Dutt, Mr., *disc.*, agriculture in Lower Bengal, 429

L.

Label for plants, notice of competition, 5; presentation of prizes, 14; report of the council, 801
Lace and fan exhibition at Brussels, 51
Laing, D. G., *obituary*, 51
Lamp, miners' safety, 29; prize offered for, 193, 419, 484; report of council, 801
Lapland, iron ore fields of, 91
Lathe, the modern, its manufacture and uses, *paper* by J. H. Evans, 256
Lepper, Charles H., *paper*, overland commercial communication between India and China, *viâ* Assam, 305; *letter*, 343
Lever, Ellis, offer of prize for miners' safety lamp, 193, 484
Library, additions to, 377, 960
Life-saving and hygiene exhibition at Berlin, 1883, 723
Liggins, H., *disc.*, collisions at sea, 48; *disc.*, artificial drying of crops, 73; *disc.*, utilisation of waste, 113; *disc.*, sanitary inspection of houses, 187; *disc.*, Suez canal, 213; *disc.*, social condition and prospects of Madagascar, 283; *disc.*, increasing destruction of life and property by fire, 373; *disc.*, development of Irish industries, 440; *disc.*, social and commercial aspects of New Zealand, 466; *disc.*, transmission of power by electricity, 541; *disc.*, English and foreign silver work, 662; *disc.*, prevention of fires in theatres, 749; *disc.*, development of electric lighting, 789; annual meeting, scrutineer, 794
Light in the textile industry, 993
Lightfoot, T. B., *disc.*, ice-making and refrigerating, 23; *paper*, a new process for the separation and recovery of the volatile constituents of coal, 669
Lighthouses, colonial, 33
Lignification, technical aspects of, *paper* by C. F. Cross, 220; *letter* by F. Routledge, 268; *letter* by C. Cross, 302
Lilley, Sir Charles, *disc.*, Queensland, its progress and resources, 767
Locomotive engines, compound, 280
Locomotives, electric head-light for, 94
Locusts in the Bombay Presidency, 868
Lodge, Prof. Oliver J., *Cantor lectures*, secondary batteries, 1025, 1038; syllabus, 686
London improvements, cost of, 649
London, school children of the metropolis, *letter* by E. Chadwick, 29
Long, Rev. J., *disc.*, agriculture in Lower Bengal, 428; *disc.*, fisheries of India, 629; *disc.*, domestic architecture of India, 742
Louisville exhibition, 667, 712
Lovibond, T. W. *disc.*, formation of diastase from grain, 556
Lyons, sericiculture at, and at Smyrna, 375

M.

Machinery, agricultural, recent improvements in, *paper* by D. Pidgeon, 317
Mackay, Mr., *disc.*, life among the Turcoman Nomads, 255
Mackenzie, Mr., *disc.*, trade routes of Persia, 495
Maclagan, General, *disc.*, domestic architecture of India, 740
MeMillan, Walter G., *paper*, some causes of fires, and methods for their prevention, 380
Madagascar, social condition and prospects of, *paper* by the Rev. J. Peill, 271
Madrid mining exhibition, 756
Magnus, Philip, *paper*, technical instruction in elementary and intermediate schools, 695
Mair, John G., *disc.*, ice-making and refrigerating, 24
Malay peninsula, tin ore in the, 810
Mann, Dr. R. W., F.R.C.S., *disc.*, Egypt present and to come, 359; scrutineer, 794
Marble, E. W., *letter* to Sir F. Bramwell, on American patent law, 511
Marine (merchant) of the world, 95
Marlborough, Duke of, K.G., *obituary*, 832
Marriott, Mr., *disc.*, prevention of fires in theatres, 747
Marseilles maritime exhibition, 1036; international exhibition, 981
Massey, Mr., *disc.*, the modern lathe, 267
Maskelyne, N. Story, M.P., F.R.S., *disc.*, electricity as a motive power, 644
Mast, Christian, *disc.*, economy in sanitation, 590
Mate, or Paraguay tea, 728, 899
Matthew, Mr., *disc.*, historical development of the different settlement systems of India, 529
Matthey, George, F.R.S., *chair*, on the increasing destruction of life and property by fire, 363
Meat, preservation of, 729

MEDALS:—
Presentation of, for session 1881-2, by chairman of council, 13
Albert, gold, list of awards, 379; award to Sir Joseph Hooker, K.C.S.I., 775; report of the council, 798
Society's silver, for papers read, to D. Pidgeon, A. J. H. Hipkins, A. Siemens and E. Hopkinson, Capt. Douglas Galton, F. Seymour Haden, E. O'Donovan, Col.-Bateman Champain, W. S. Seton-Karr, W. G. Pedder, 757; report of the council, 798
For house sanitation, 14
MEETINGS OF THE 129TH SESSION:—
ANNUAL MEETING, 793
CHEMISTRY and PHYSICS (APPLIED) SECTION (see "Chemistry")
FOREIGN AND COLONIAL SECTION (see "Foreign")
INDIAN SECTION (see "Indian")
ORDINARY:—
Report, 794
1st Meeting:—Opening address by Sir William Siemens, F.R.S., 6
2nd Meeting:—"Ice-making and refrigerating," by J. Hopkinson, D.Sc., F.R.S., 19
3rd Meeting:—"Collisions at sea," by Capt. P. H. Colomb, R.N., 36; adjourned discussion, 53
4th Meeting:—"The artificial drying of crops," by William A. Gibbs, 61
5th Meeting:—"Electrical exhibitions," by W. H. Preece, F.R.S., 80
6th Meeting:—"The utilisation of waste. A quarter of a century's progress," by P. L. Simmonds, 97
7th Meeting:—"The sanitary inspection of houses," by W. K. Burton, 177
8th Meeting:—"The Suez canal," by Lieut.-General Rundall, 195
9th Meeting:—"On ensilage in the United States," by Professor Thorold Rogers, M.P., 229
10th Meeting:—"The modern lathe," by J. H. Evans, 256
11th Meeting:—"The Society of Arts patent bill, and some points in American law and practice bearing thereon," by Sir Frederick Bramwell, 285
12th Meeting:—"Recent improvements in agricultural machinery," by D. Pidgeon, 317
13th Meeting:—"The increasing destruction of life and property by fire; what is the remedy?" by Cornelius Walford, 363
14th Meeting:—"The history of the pianoforte," by A. J. Hipkins, 397; appendix, 949
15th Meeting:—"The development of Irish industries," by John Caldwell Bloomfield, 432
16th Meeting:—"The measurement of electricity," by J. N. Shoolbred, 497
17th Meeting:—1. "The transmission of power by electricity;" 2. "The Portrush railway," by Alexander Siemens and Edward Hopkinson, 531
18th Meeting:—"The Government patent bill," by H. Trueman Wood, B.A., Secretary of the Society, 558; adjourned discussion, 593
19th Meeting:—"Economy in sanitation," by Capt. Douglas Galton, C.B., F.R.S., 575
20th Meeting:—"Electricity as a motive power," by Professor George Forbes, 631
21st Meeting:—"English and foreign silver work; with remarks on the plate duties, compulsory hall-marking, and the constitution of the Goldsmiths' Company," by Wilfred Cripps, 652
22nd Meeting:—"Technical instruction in elementary and intermediate schools," by Philip Magnus, B.Sc., B.A., 695
23rd Meeting:—"The relative claims of etching and engraving to rank as fine arts," by F. Seymour Haden, F.R.C.S., 714
Members, number of, report of the council, 804
Merchant marine of the world, 95
Meridians, uniform, and time, 730
Mersey railway, 980
Metal, decorative treatment of, in architecture, *Cantor lectures*, by G. H. Birch, 905, 917, 937; syllabus, 416
Metal industry in Austria, 95
Metals (precious), abolition of the Mexican export tax on, 103
Meteorological instruments, exhibition of, 303
Mexico, asphalte deposits of, 818; exports of textile goods to, 95; abolition of export tax on precious metals, 103; fibrous plants of, 1035; production of gold and silver in, 1062; textile industry, 1045
Michie, A., *disc.*, overland route towards China, 318
Middlesbrough, electric light at, 1003; salt working at, 1063
Minchin, J. W., fibre plants of India, 893
Mincard, G. E., presentation of medal to, for the sanitary arrangements of his house, 14; *disc.*, sanitary inspection of houses, 188
Miners' safety lamp, 193, 419, 484; report of council, 801
Mineral wealth of Belgium, 511
Minerals in Cochin China, 415; in the United States, 892
Mines and minerals from Servia, 809
Mining exhibition at Denver, 607; at Madrid, 756
——— statistics of the United Kingdom, 876
———- and reduction of quicksilver, 192
Mirrors, silvering, by means of glycerine, 515
Mitchell, H., *letter*, prevention of fires in theatres, 773
Moncrieff, W. D. Scott, *disc.*, transmission of power by electricity 540; *disc.*, electricity as a motive power, 643
Moresby, Rear-Admiral, *disc.*, collisions at sea, 49
Morgan, Mr., *disc.*, Government patent bill, 599
Moseley, Prof., F.R.S., *Juvenile lectures*, the inhabitants of the ocean, 137, 159
Moss, H., *disc.*, technical instruction in elementary and intermediate schools, 708
Mozambique, agriculture in, 878
Munich art exhibition, 136, 468, 820
Music, practical examination in vocal and instrumental, 652
Mylne, James, presentation of medal to, 13

N.

Nancy, embroidery industry at, 1047
Nasmyth, D., *disc.*, increasing destruction of life and property by fire, 373
Naval architects, institution of, 376
New South Wales, coal in, 1024; iron industry of, 1006
New York, electric lighting in, 515; industries, 856; underground railway, 774
New Zealand, *letter* by F. Tayler, 514; coal-fields of, 742; social and commercial aspects of, *paper* by W. Delisle Hay, 447; timber supply, 666
Newlands, B. E. R., *disc.*, new process for the separation and recovery of the volatile constituents of coal, 677
Newport, George, and Prof. Ronalds' analyses of peaty water, 482
Newspapers in India, 1007
Newton, A. V., *letter*, Government patent bill, 602
Newton, W. E., *disc.*, the Society of Arts patent bill, 295
Nice international exhibition, 774, 975
Nicholson, Mr., *disc.*, agricultural machinery, 337

O.

OBITUARY:—
Blashfield, J. M., 136
Campin, F. W., 514
Corbaux, Fanny, 303
Dilke, Ashton W., 445
Fitzgerald, Lord Otho, 33
Harrowby, Earl of, 33
Hutt, Sir William, K.C.B., 51

Laing, D. G., 51
Marlborough, Duke of, K.G., 832
Ripley, Sir H. W., 33
Scott, General, F.R.S., 607
Spencer, Peter, 844
Spottiswoode, Wm., P.R.S., 819
Varley, Cromwell, F.R.S., 936
Watson, Sir Thomas, F.R.S., 94
Young, James, F.R.S., 685
Report of the council, 804
Ocean, inhabitants of the, *Juvenile lectures* by Prof. H. N. Mosely, 137, 159
O'Donovan, Edmund, *paper*, life among the Turcoman Nomads, 246; Society's silver medal awarded to, 757
Offor, George, *disc.*, development of electric lighting, 787
Oil, cotton seed, 167
Oils (see "Illuminating Agents")
Olive in Siena, 1005
Oman, commerce, industries, and resources of, 442
Ondaatje, Dr. W. C., *disc.*, utilisation of waste, 113; *disc.*, fisheries of India, 629
Owensmith, Mr., *disc.*, increasing destruction of life and property by fire, 373

P.

Paint, incombustible, 648
Palm, dwarf, as a paper-making material, 892, 1034: *letter* by T. Fletcher, 1047
Pandanus, or screw-pine bread, 955
Paper from bark, 93
Paper-making material, 822, 935, 1034
Paper mills of the world 792, 868
Paraffin, bleaching of, 443
Paraguay tea, 728, 899
Parcels post, 901; in Belgium, 118
Parfitt, Capt., *disc.*, collisions at sea, 53
Paris, academy competition and prizes, 514, 543; aeronautical exhibition, 711; ceramic and glass exhibition, 992; congress of "Institution de Prevoyance," 792; Societé de Encouragement, prizes offered by, 411
Pascall, G. W., *letter*, utilisation of diseased potatoes, 468
Patent agents, formation of institute of, 78
Patent bill, Society of Arts, 175, 177, 305, 347; resolution of the Chambers of Commerce, 175; proceedings in the House of Commons, 375
———————————, and some points in American patent law and practice bearing thereon, *paper* by Sir Frederick Bramwell, 285
———————, Government, 466, 573, 667, 726; *paper* by H. Trueman Wood, 558; adjourned discussion, 593; analysis, 863; third reading, 879; memorial on printing of specifications, 864; analysis of the act, 904, 929
Patent law, report of the council, 798; committee's report, British Association, 964
—— —— reform, deputation to the president of the Board of Trade, 811
—— ——, American, *letter* from E. W. Marble to Sir Frederick Bramwell, 511; Swiss, 1024
Patent office indexes, 134
Patents in 1882, 243
Paul, H. Moncrieff, *disc.*, social and commercial aspects of New Zealand, 463
Payne, Alexander, *disc.*, domestic architecture of India, 741
Payne, W. J., *letter*, inquiries into the causes of fires, 370
Pearce, Mr., *disc.*, ensilage in the United States, 238
Pearson, Col., presentation of medal to, 13
Pearson, Rev. Mr., *disc.*, technical instruction in elementary and intermediate schools, 769
Peaty waters, self-purification of, *paper* by Professor W. D. Hartley, 469; *letter* by Dr. C. Tidy, 542
Pedder, W. G., *disc.*, fisheries of India, 630; *paper*, historical development of the different settlement systems of British India, 517; *disc.*, domestic architecture of India, 742; Society's silver medal awarded to, 757; elected member of council, 833
Peill, Rev. J., social conditions and prospects of Madagascar, 271
Pelly, Sir Lewis, K.C.B., *chair*, trade routes of Persia, 487; *disc.*, relative claims of etching and engraving to rank as fine arts, 722
Pennsylvania, anthracite coal-fields of, 28
Penny post, John Hill's, 989
Perkins's, Jacob, ice-making machine, *letter* by Sir Frederick Bramwell, 76
Perry, Prof. J., *letter*, hydraulic machinery, 302
Persia, trade routes of, *paper* by Col. Bateman-Champain, 487; *letter* by J. J. Fahie, 571
Petroleum, new sources of, 728; supply of Baku, 818
Pfoundes, C., *disc.*, overland route towards China, 315; *disc.*, social and commercial aspects of New Zealand, 466; *disc.*, relative claims of etching and engraving to rank as fine arts, 722; *disc.*, Queensland, its progress and resources, 766
Phillips, C. D., *disc.*, ensilege in the United States, 237; *disc.*, artificial drying of crops, 73; correction, 115
Phosphate industries of America, 15
Photographic exhibition at Brussels, 217
———— reproduction, new process, 118
Photometric standards, 91
Pianoforte, history of the, *paper* by A. J. Hipkins, 397; appendix, 949
Pidgeon, D., *paper*, recent improvements in agricultural machinery, 317; Society's silver medal awarded to, 757
Pitman, William, annual meeting, 805
Plant label competition, notice, 5; presentation of prize to E. J. Alment, 14; report of council, 801
Plants, economic, in the Ceylon botanic garden, 828; of India, 50; at Kew, 569, 603; in Jamaica, 725
Poole, Mr., *disc.*, social condition and prospects of Madagascar, 284
Poppy, cultivation of the, in Roumelia, 665
——— seeds in India, 891
Population of France, 729
Portrush electrical railway, *paper* by A. Siemens and E. Hopkinson, 531; *letter* by H. Barcroft, 573
Post (penny), John Hill's, 989
Post-office report, 888
Potatoes, utilisation of diseased, 444; *letter* by G W. Pascall, 468
Pottery trade in the Black Forest, 710
Power, transmission of, by electricity, 136; *paper* by Alexander Siemens and E. Hopkinson, 531
Prague, electrical and industrial exhibition, 193
Precious metals, abolition of tax in Mexico, 193
Preece, W. H., F.R.S., *paper*, electrical exhibition, 80; *disc.*, measurement of electricity, 509; *chair*, transmission of power by electricity and the Portrush railway, 531; *disc.*, Government patent bill, 597; *chair*, electricity as a motive power, 631; *chair*, *Cantor lectures*, on transmission of energy, 651; thanks of council voted for his paper, 757
Premiums for the 129th session, 195; report of the council, 800
Price, Mr., *disc.*, social condition and prospects of Madagascar, 284
Price, W. F., *letter*, artificial drying of crops, 72
PRIZES, OFFER OF:—
Fothergill, 195
Howard, 195
Jones, Owen, 245; report of council, 801; awards, 1883, 905
Mulready, 195
Shaw, Benjamin, 195
Stock, John, 195
Swiney, 757; report of the council, 801
Presentation of, for plant label, 14 (see "Medals")
Prizes offered by the Societé d'Encouragement, 411

Pumping apparatus, exhibition of, at Cagliari, 667, 810, 844, 948
Pyrites refuse, utilisation of, for steel-making, 416

Q.

Queensland, its progress and resources, *paper* by A. J. Stanesby, 758; *letter* by John Robinson, 792
Quicksilver, mining and reduction of, 192
Quinlan, T. *disc.*, development of Irish industries, 441

R.

Railway safety exhibition, 118
———, Portrush electrical, *paper* by A. Siemens and E. Hopkinson, 531; *letter* by H. Barcroft, 573
———, St. Gothard, 377
———, underground, in New York, 774
Railways of the world, 93; in India, *letter* by P. R. Cola, 606; Italian, 1034
Rainfall, British, *letter* by G. J. Symons, 94
Raisins, Smyrna, production of, 1035
Ransome, Mr. *disc.*, agricultural machinery, 337
Rawlinson, Sir Robert, C.B., *disc.*, sanitation inspection of houses, 185; *chair*, economy in sanitation, 575
Rawson, Woodham, *disc.*, development of electric lighting, 790
Reckenzaun, A., *disc.*, transmission of power by electricity, 540; electricity as a motive power, 643
Reddie, A. W. L., *disc.*, ice-making and refrigerating, 25; *disc.*, Government patent bill, 568
Redman, J. B., *disc.*, increasing destruction of life and property by fire, 373
Refrigerating, ice-making and, *paper*, Dr. J. Hopkinson, 19
Renouf, Mr., *disc.*, Society of Arts' patent bill, 298
Reynolds, Mr., *disc.*, increasing destruction of life and property by fire, 374
Reynolds, Prof. Osborne, F.R.S., *Cantor lectures*, the transmission of energy, 973, 985, 995, syllabus, 544
Rhodes, Parker, *disc.*, collisions at sea, 54
Rice, cultivation of, in Japan, 16
Rigg, Rev. Arthur, memorial to, 730
Ripley, Sir H. W., *obituary*, 33
Rivers (peaty), self-purification of, *paper* by Prof. W. N. Hartley, 469; *letter* by Dr. C. M. Tidy, 542
Robins, E. C., *disc.*, sanitary inspection of houses, 186; *disc.*, economy in sanitation, 591; *disc.*, technical instruction in elementary and intermediate schools, 709
Robinson, John, *letter*, Queensland, 792
Robinson, Sir W. Rose, K.C.S.I., *disc.*, agriculture in Lower Bengal, 430; *disc.*, historical development of the different settlement systems of India, 527
Robinson, Vincent, *disc.*, domestic architecture of India, 742
Robottom, Mr., *disc.*, utilisation of waste, 113
Rogers, J. B., *disc.*, development of Irish industries, 441
Rogers, Prof. J. E. Thorold, M.P., *paper*, ensilage in the United States, 229
Roman fire brigade, 1045
Ronalds, Prof., and G. Newport's analyses of peaty water, 482
Roumelia, cultivation of the poppy in, 665
Routledge, T., *disc.*, utilisation of waste, 112; *letter*, technical aspects of lignification, 268
Royal Institution, 175, 607
Rundall, General, *paper*, the Suez canal, 196; *letter*, Suez canal statistics, 301; *letter*, Egypt, 413; *disc.*, agriculture in Lower Bengal, 430
Russia, coal and iron industries of, 934; fisheries of, 865; grape culture and wine-making in, 970; textile industry of, 416
Russian section of fisheries exhibition, 770; trade with Asia, 772

S.

Safety lamp, a new one by M. Lechein, 29
———— miners', 193, 419, 484; report of committee, 811
St. Gothard railway, 377
St. Petersburg, horticultural exhibition at, 413, 607
Salt, production of, of Cadiz, 192; in Turk's Island, 192; working at Middlesbrough, 1004
San Francisco, canned fruit trade of, 960
Sanitary inspection of houses, *paper* by W. K. Burton, 118; *letters*, J. W. Wood, 216; Rogers Field, 240; W. F. Buchan, 242; C. N. Cresswell, 242; Captain Galton, 242; W. H. Denham, 302; J. W. Wood, 302
Sanitation, economy in, *paper* by Capt. Douglas Galton, C.B., 575
————, house, competition, presentation of medals, 14
Saunders, Trelawney, *disc.*, life among the Turcoman Nomads, 254; *disc.*, overland route towards China, 314; *disc.*, Egypt present and to come, 360
School board drill, 810
School children of the metropolis, *letter* by E. Chadwick, 11
Schools, elementary and intermediate, technical instruction in, *paper* by P. Magnus, 695
————, technical, in France, 243
Scott, Mr., *disc.*, development of Irish industries, 441
Scott, General, F.R.S., *obituary*, 607
Screw guage committee of the British Association, report, 111
——— threads, standard, in the United States, 135
Sea-weed, Japanese, 91
Secondary batteries, *Cantor lectures* by Prof. Oliver J. Lodge, 1025, 1038; syllabus, 686
Selwyn, Admiral, *disc.* Government patent bill, 560
Sericiculture at Lyons and at Smyrna, 375
Servia, mines, and minerals from, 809
Sessional arrangements, 1882-3, 1; 1883-4, 1037, 1049
Seton-Karr, W.S., *paper*, agriculture in Lower Bengal, 418; *disc.*, fisheries of India, 629; Society's silver medal awarded to, 757
Settlement systems of India, historical development of the different, *paper* by W. G. Pedder, 517
Sewage treatment at Wrexham, *letter* by C. N. Cresswell, 1050
Shaw, Capt. Eyre, C.B., *chair*, some causes of fire and methods for their prevention, 380
Shean, A.W.C., *disc.*, increasing destruction of life and property, 372; *disc.*, prevention of fires in theatres, 748
Sherborne, Mr., *disc.*, agricultural machinery, 337
Shippey, Arthur, *disc.*, collisions at sea, 57
Shoolbred, J. N., *disc.*, electrical exhibitions, 83; *paper*, the measurement of electricity, 497; *disc.*, transmission of power by electricity, 641; *disc.*, electricity as a motive power, 641
Shore, Hon. H. N., English goods and Chinese buyers, 811
Sicily, wines of, 935
——— and Calabria, submarine communication between, 160
Siemens, Alexander, and Edward Hopkinson, *papers* on the transmission of power by electricity; (2) the Portrush electrical railway, 531; Society's silver medal awarded to, 757
Siemens, Sir William, F.R.S., opening address of the 1882 session, 6; *chair*, ice-making and refrigerating, 19; *chair*, measurement of electricity, 497; *disc.*, Government patent bill, 598; *chair*, prevention of fires in theatres, 748; *chair*, annual general meeting, 793; *letter* to Sir William Harcourt on fires in theatres, 811; elected chairman of council, 821
Siena, vine and olive in, 1005
——— earths, production of, 934
Silk, Syrian, 984; Tusser, 769
——— farming in Turkey, 933
——— industry of the world, 1043
———, manufacture of, at Crefeld, 1046
Silk-producing Bombyces, reared in 1882 by A. Wailly, 182, 214, 239, 349
Silkworm culture in Ceylon, 856
Silver work, English and foreign, *paper* by Wilfred Cripps, 1021

Silver and gold, production of, in Mexico, 959
Simmonds, P. L., *paper*, the utilisation of waste, a quarter of a century's progress, 97; *letter*, 157
Sinclair, Mr., *disc.*, some causes of fire and methods for their prevention, 396
Slag, vanadic acid from blast furnace, 33
Smyrna, sericiculture at Lyons and at, 375
——— raisins, production of, 1035
Smythe, Mr., *disc.*, the modern lathe, 266; *disc.*, agricultural machinery, 338
Society of Arts—Flaxman's medals, 416; renovation of the house, 5; report of council, 803; fish monopoly in 1761, 979
Sohn, C., *letter*, spectroscopic observations of the comet, 18
Soot prevention, appliance for, 118
Spagnoletti, C. E., *disc.*, electricity as a motive power, 642
Spectroscopic observations of the comet, *letter* by C. Sohn, 18
Spence, Peter, *obituary*, 844
Spiller, J., *disc.*, some causes of fire and methods for their prevention, 396
Sponge trade of the Bahamas, 410
Spongy iron, antiseptic action of, *letter* by Gustav Bischof, 447; *letter* by Jabez Hogg, 467
Spottiswoode, Wm., P.R.S., *chair*, electrical exhibitions, 79; *chair*, development of electric lighting, 778; *obituary*, 819
Stainer, Dr. John, *chair*, history of the pianoforte, 397
Stanesby, Arthur J., *paper*, Queensland, its progress and resources, 758
Stanley, Hon. Edward Lyulph, M.P., *chair*, technical instruction in elementary and intermediate schools, 695
Steel-making, utilisation of pyrites refuse for, 416
Stevenson, J. C., M.P., *disc.*, new process for the separation and recovery of the volatile costituents of coal, 677
Stoker, G. N., self-purification of peaty rivers, 483
Storr, Mr., *disc.*, economy in sanitation, 592
Straw goods, manufacture, 1003
Streeter, E. W., *disc.*, English and foreign silver work, 662
Submarine cables, 94
——— exploration, 904
Suez Canal, its engineering, commercial, and political aspects, *paper* by General Rundall, 196; proposed new one, 681; statistics, *letters*, W. M. Wood, 300; General Rundall, 301
Swan, Mr., *disc.*, increasing destruction of life and property by fire, 374
Swiney prize, 757; report of the council, 801
Swinton, Mr., *disc.*, increasing destruction of life and property by fire, 373
Swiss national exhibition at Zurich, 729, 890
——— patent law, 1024
Switzerland, cotton industries of, 1004; wines of, 484
Sydney, steam tramways in, 994, 1006
Symons, G. J., F.R.S., *letter*, British rainfall, 94
Syrian silk, 984

T.

Tanning textile fabrics, 916
Tasar silk, 769
Tayler, F., *letter*, New Zealand, 514
Tea (Paraguay), or *maté*, 728, 899
Tea culture in the United States, 948
Tea trade of China and Japan, 856
Technical instruction in elementary and intermediate schools, *paper* by P. Magnus, 695
——— schools in France, 243
——— examinations, 864
Telegraphs, electric, in Europe, 832
———, report of the council, 802
Telephone statistics, 17, 1052
Textile fabrics, tanning, 906; exports of, to Mexico, 95
——— industry, light in the, 993; of Russia, 416; of Mexico, 1045
Thames pollution, 903
——— water, reports on the examination of, 74, 87
Theatres, electrical safety appliance for, 515
———, iron curtain for, 269
———, prevention of fires in, meeting to consider report on, 746; resolutions passed, 753; *letter* by H. Mitchell, 773; report of the council, 799; *letter* to the Secretary of State for the Home Department, 811
Thomas, S. G., presentation of medal to, 13
Thompson, Prof. Silvanus P., D.Sc., *Cantor lectures*, dynamo-electric machinery, 119, 137, 159; syllabus, 2; presentation of medal to, 13
Thwaite, B. H., *letter*, iron drain pipes with lead joints, 242
Tidy, Dr. C. M., *letter*, self-purification of peaty rivers, 542
Timber supply, New Zealand, 666
Time, uniformity of, 730, 1006
Tin ore in the Malay peninsula, 810
Tinned foods, 1046
Tobacco statistics in France, 820
Torrens, W. M'Cullagh, M.P., *chair*, Queensland, its progress and resources, 758
Tramcar, air driven, 684
Tramways, steam, in Sydney, 994, 1006
Treasurer's report, 776
Trevithick, R., proposed memorial to, 33
Tunnel, proposed submarine, between Sicily and Calabria, 269
Turcoman Nomads, life among the, *paper* by E. O'Donovan, 246
Turin exhibition, 711
Turk's island, production of salt in, 727
Turkey, silk farming in, 933
Turner, Mr., *disc.*, agricultural machinery, 338
Turners' company, livery presented to Dr. Siemens and Dr. Percy, 175
Tweddell, R. H., Society of Arts' patent bill, 296; *letter*, Government patent bill, 603

U.

United States, bromine in the, 1047; cotton industry in the, 444; cultivation of flax in the, 412; ensilage in the, *paper* by Prof. J. E. Thorold Rogers, M.P., 229; gold production in the, 646; minerals in the, 892; phosphate industries of, 15; tea culture in the, 948

V.

Vanadic acid from blast furnace slag, 33
Varley, Cromwell, F.R.S., *obituary*, 936
Varley, F., *disc.*, measurement of electricity, 509
Venetian industrial arts, revival of, 999
Venezuela, agriculture in, 958
Venice, vine cultivation at, 18
Verney, F. W., *disc.*, social condition and prospects of Madagascar, 282
Vibert, A. R., *disc.*, collisions at sea, 57
Vienna, electrical exhibition at, 78, 345, 607, 685; exhibition of graphic arts, 685
Vine and olive in Siena, 1005
—— cultivation at Venice, 18
—— disease in France, 727
Vineyards in California, 34
Vivian, Sir H. Hussey, Bart., *chair*, a new process for the separation and recovery of the volatile constituents of coal, 669
Voelcker, Dr. A., F.R.S., *chair*, artificial drying of crops, 60; *disc.*, ensilage in the United States, 235; *disc.*, self-purification of peaty rivers, 481
Volta prize, 515
Vosges district, industry of the, 868

W.

Wailly, A., silk producing bombyces reared in 1882, 189, 214, 239, 340
Walford, Cornelius, *paper*, the increasing destruction of life and property by fire; what is the remedy? 363; *disc.*, Government patent bill, 568; *disc.*, prevention of fires in theatres, 747
Walker, D., *disc.*, technical instruction in elementary and intermediate schools, 709
Wallace, R. W., *disc.*, Government patent bill, 599
Walpole, Spencer, presentation of medal to, 13
Ward, F. P., annual meeting, 806
Warington, R., *disc.*, self-purification of peaty rivers, 483; presentation of medal to, 13
Warren, Mr., increasing destruction of life and property by fire, 372
Waste, utilisation of, a quarter of a century's progress, *paper* by P. L. Simmonds, 97; *letters*, H. Clements, 135; P. L. Simmonds, 157
Watch manufacture in England, 1021
Water, chemical analysis of drinking, *letter* by Jabez Hogg, 414; report on the examination of Thames, 74, 87; examination, 215
Waterproof clothing, 868
Waters, underground, ninth report of the British Association committee, 1000
Watherston, E. J., *disc.*, development of Irish industries, 440
disc., English and foreign silver work, 661
Watson, James, *disc.*, Government patent bill, 600
Watson, Sir Thomas, Bart., F.R.S., *obituary*, 94
Wax-plant, 94
Webster, Richard E., Q.C., *chair*, Government patent bill, 558, 593
Wethered, Col., *disc.*, destruction of life and property by fire, 372
Wheat, Indian, 807
White, Charles, *disc.*, increasing destruction of life and property by fire, 372
White, D. S., *disc.*, fisheries of India, 629
White, R. B., *disc.*, self-purification of peaty rivers, 483
White, Surgeon-Major, *disc.*, overland route towards China, 313
White-lead, non-poisonous, 1024
Wilkins, General St. Clair, *disc.*, domestic architecture of India, 741
Wilson, James, *disc.*, the Society of Arts patent bill, 297
Wine-making in Russia, 970
Wines of Sicily, 935; Switzerland, 484
Wise, W. Lloyd, *disc.*, Government patent bill, 598
Wolstenholme, Mr., *disc.*, the Society of Arts patent bill, 298
Wood, H. Trueman, secretary, *disc.*, the modern lathe, 281; *paper*, the Government patent bill, 568; adjourned discussion, 593, 600; thanks voted by council for his paper, 730; acknowledges vote of thanks to himself and colleagues at annual meeting, 806
Wood, J. T., *disc.*, Suez Canal, 212
Wood, J. W., *letters*, sanitary inspection of houses, 708, 910
Wood, W. Martin, *disc.*, ice-making and refrigerating, 631; *disc.*, Suez Canal, 211; *disc.*, life among the Turcoman Nomads, 254; *disc.*, Madagascar, 283; *letter*, Suez Canal statistics, 300; *disc.*, Egypt, present and to come, 360; *disc.*, agriculture in Lower Bengal, 431; *disc.*, development of Irish industries, 441; *disc.*, trade routes of Persia, 611; *disc.*, historical development of the different settlement systems of India, 530; *disc.*, fisheries of India, 630; *disc.*, English and foreign silver work, 661; *letter*, bounty on electro plate, 685; *disc.*, domestic architecture of India, 742; *letter*, on more material for paper-making, 935
Wood-carving, school of art, 303, 994
Woodward, Rev. Mr., *disc.*, social condition and prospects of Madagascar, 283
Wool vegetable, 972
Woollen industry of Belgium, 175
——— trade in France, 868
Wrexham, sewage treatment at, *letter* by C. N. Cresswell, 1050

Y.

Yarn, numbering of, 241
Yeats, Dr. John, *letter*, earlier harvests and change of seeds, 880
Yorkshire coal mines, 975
Young, James, F.R.S., *obituary*, 685
Yucatan, production, population, and trade of, 1033
Yucca draconis, the giant cactus, *letter* by W. M. Wood, 938

Z.

Zapallo fruit, 607
Zurich exhibition, 729, 190

PRINTED BY W. TROUNCE, 10, GOUGH-SQUARE, FLEET-STREET, LONDON, W.C.

GETTY CENTER LIBRARY
3 3125 00628 9272